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Papers and Transactions for 1909

AND

Proceedings

OF THE

Twenty-Sixth Annual Meeting

AT

NEW HAVEN, FEBRUARY 8 AND 9, 1910

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1910

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ORGANIZED AT BRIDGEPORT, JANUARY 15, 1884

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EIGHT WEEKS CIVIC STUDY ABROAD.

By F. Luther Ford, Mem. Conn. Soc. C. E.

My sympathy goes out to you, gentlemen, because I am going to try an experiment similar to the one I tried in this same place two years ago. Then I gave an illustrated lecture on some studies of American cities from the civic standpoint. I am going to spring a new one on you to-day, a similar lecture from an European standpoint. I do not know how it will work out. Some of the slides which I am to show you did not reach me last night. Out of a collection of about four hundred and fifty I wanted to select about one hundred and twenty-five which would fairly represent the various municipal improvements which I inspected abroad.

The trip which I made last summer consisted of about ten weeks, eight weeks abroad and the balance going and coming. During that time I visited about thirty-five prominent towns in England, Scotland, Belgium, Holland, Germany, Austria and France. After this experience I want to advise that, if any of you are contemplating a similar trip, do one of two things,—either allow double the time for the trip, or else cut out about half the cities, because it is altogether too strenuous to attempt to cover such a large number of cities in such a limited time.

The trip was made on the steamship *Campania,* one of the speediest and most seaworthy of the Cunard liners; in fact, it was the most speedy boat afloat previous to the arrival of the *Lusitania* and the *Mauretania.* A pleasant feature of a trip of this kind is the fact that the salt-water traveler, although separated a great distance from his friends and home, is really never out of touch with them. Any great event which happens on this side is chronicled in a paper which is daily published on the boat.

We are going to make the trip very speedily, and I will now show you the slides. The first view shows the passengers leaving the boat for Queenstown. They are to tour through Ireland before reaching Scotland and England. About seventy-five or one hundred first class passengers left the boat for Queenstown.

The distance from Queenstown to Liverpool is very short as we arrived there the following morning. The marine landing stage in Liverpool is shown in this view. It is one of the most interesting landing stages to be found in any foreign country. This portion that I show you is really a long island. The landing stage floats on a number of large pontoons. and the shore end is connected by means of bridges which are fastened at the pontoon end. This is necessary because of the variations in the tide at Liverpool. They have a very heavy tide there. It is about twenty-one feet as compared with six feet which we have here in New Haven.

BUSY SCENE IN ONE OF THE GREAT MUNICIPAL DOCKS IN LIVERPOOL, ENGLAND.

The term "dock" in Liverpool is an expression used to define an inland basin, or what we might term a harbor, which has been separated from the outside by means of gates or locks through which the boats pass into the basin. The water inside is maintained at a uniform depth of about thirty feet, so as to permit the entrance of the largest steamships, drawing perhaps twenty-eight feet of water. This shows the locks with the *Lusitania* passing through into one of these docks.

This is one of the larger docks in Liverpool, showing their construction and great use. A person who has never visited the Liverpool docks has no idea of their magnitude or the amount of shipping done there. One afternoon I walked about four hours with an engineer connected with the Dock Board, the Board having charge of the construction and maintenance of these great docks. When I was tired out and glad to stop, he informed me that we had then walked over about one-quarter of the great dock area. Not a foot of the waterfront across the Mersey River is owned by any private individual. It is all public property. It is all maintained for the benefit of the citizens themselves. Practically all of the various public utilities are handled in the same way. In Liverpool you find the heaviest street traffic of any city in the world. It is said that the horses in Liverpool draw twelve tons per horse over their fine pavements, which, of course, from our point of view, is a very heavy load.

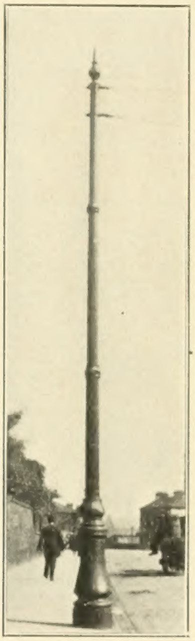
Because of the great volume of vehicle traffic and the heavy strain on the pavements, they have to be laid with a kind of material which will furnish a good foothold for horses. The great majority of the pavements along the waterfront of Liverpool are of granite. The blocks are similar to those used in America but are somewhat smaller, varying from two and a half to six inches on a side. Practically all the teaming, there, is done with horses hitched in tandem style. The drays have very wide platforms, so that along the sides of the street they are unable to set the poles close to the curbing. The poles have to be set well back into the sidewalk, in some cases as much as two feet.

It has been said that European cities lead us in the construction of public comfort stations. A view of one of the underground stations in the heart of Liverpool will show you how attractive they are. The sides are laid in porcelain, making them very attractive, and easy to keep clean. The city engineer there who had charge of the construction of this station said that he wanted to have the station attractive so that people would not object to using it. Objectionable outdoor advertising is not wholly confined to this side of the Atlantic, as you see from numerous examples in English and Scottish cities.

I regret that I did not have time to arrange the subjects for this lecture topically. The slides are actually arranged by cities.

If I repeat some of these views, it is because I want to show the difference in practice in treating these problems in the various cities and countries which I visited.

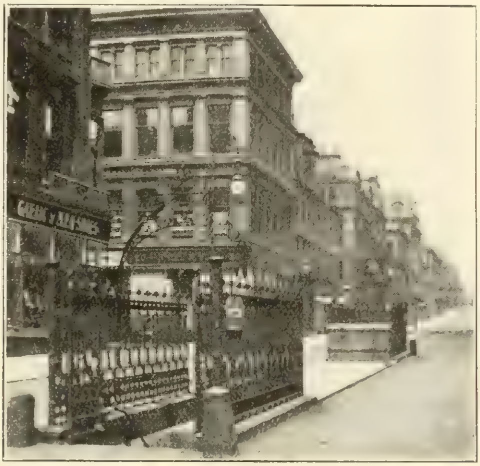
While in England and Scotland I had an opportunity to see some of the efforts which have been made to promote better sanitary conditions in the factory villages, where attempts have been made to provide sanitary, up-to-date facilities for the employees. At Port Sunlight there are perhaps two hundred modern workingmen's dwellings, all grouped together in a little village. They have their own churches, schools, gymnasiums, libraries, and everything that tends to make up a well conducted village. The front yards are unusually attractive, as the people are encouraged to plant flowers and to keep their yards in a very attractive condition.



GRACEFUL TROLLEY POLE IN GLASGOW, SCOTLAND.

At Hampstead, a suburb of London, there is a somewhat different treatment. Mr. Unwin, the architect of this town, is a strong advocate of maintaining the rural appearance in small streets. He does not believe in laying curbs and sidewalks, as we do here, but prefers to preserve the rural effect by a narrow roadway more or less winding. He is also a strong advocate of narrower residential streets.

This view was taken to show an ornamental trolley pole. Instead of two or three tubular sections which are so common in American trolley poles, with no attempt at artistic treatment, notice this pole in Glasgow, Scotland. It has a heavy base, which gives the pole the appearance of stability, and at the joints, or at the end of each of the tubular sections, notice the treatment. Also notice the graceful taper of this pole. It is artistic.

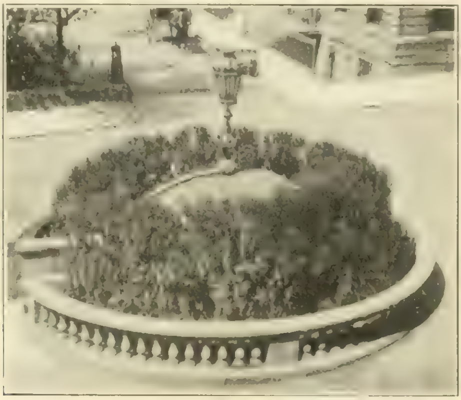


PUBLIC URINAL, FOR MEN ONLY, IN CENTER OF GLASGOW STREET.

In Glasgow, the first city visited in Scotland, they also have very heavy traffic in the streets, and in a great many cases there are very steep grades. They lay what are called "wheelers," so that the heavy truck wheels will track upon these flagstones. They are usually about twelve to eighteen inches in width, and sustain the weight of the teams passing over these streets. They are constructed to stand very heavy traffic.

In a great many cases in Glasgow the public conveniences are constructed in the center of the streets. This one in the view is for the use of men only. They enter at one end and pass out at the other end, the urinal stalls are on one side of the passage-way and the toilets upon the opposite side. The object of this plan is to get proper ventilation through the station.

Here is an interesting view of a memorial fountain which was erected in Glasgow at the intersection of two prominent streets. At the right is the underground entrance to the public convenience. The people in this neighborhood are of the better class, and the object was to get a design which would be acceptable to such a residential section, and this design was finally adopted.



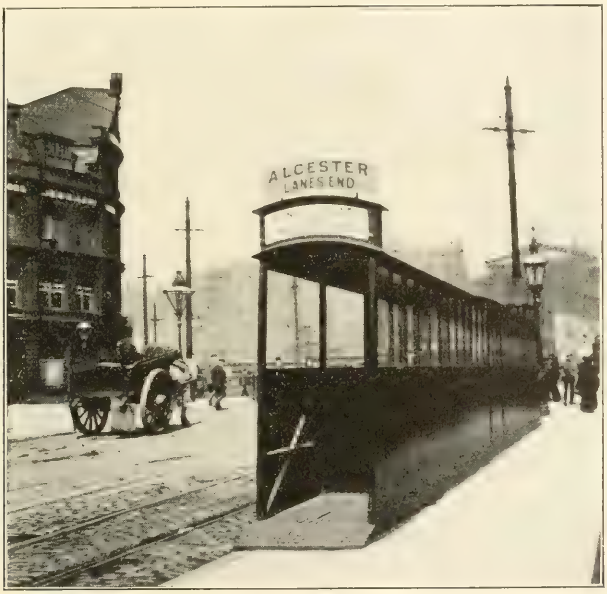
ARTISTIC TREATMENT OF UNDERGROUND PUBLIC
COMFORT STATION IN STREET IN
GLASGOW, SCOTLAND.

You will notice that the entrance is right behind the drinking fountain, so that people entering and leaving the station are somewhat hidden from view. This station had four or five urinals and two closets.

We have been told that all of the best pavements come from Scotland. I expect that when we are laying granite block pavement we should adopt the Scotch custom of assorting the blocks before they are laid. With us the blocks are usually dumped on the street, as they are received from the cars, and no attempt is made to assort them.

While in Glasgow I went down the Clyde River. It is said that Glasgow made the Clyde, and the Clyde then made Glasgow.

The Clyde River bears about the same relation to Glasgow that the Connecticut River does to Hartford. It is at the head of sloop navigation. Many years ago it was said that persons could walk across the Clyde, especially in the summer time. Since then enormous improvements have been made in the river. They have a corporation which operates all of the shipping interests on this river, and has charge of the developing and improving of the river under municipal control and authority.

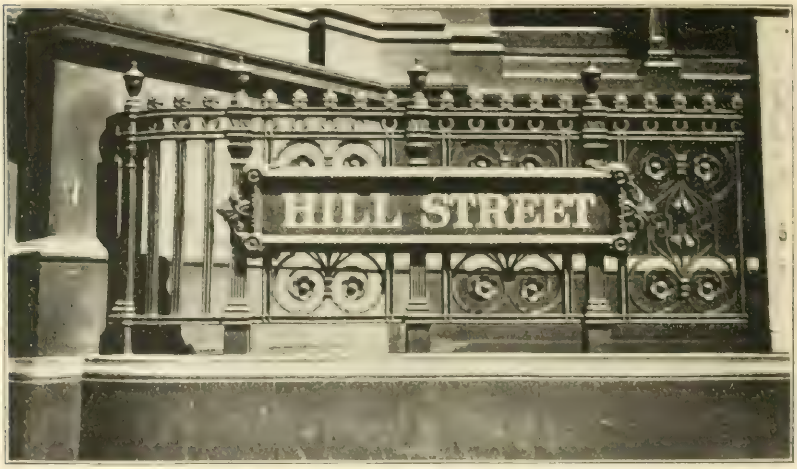


UNIQUE TROLLEY WAITING STATION IN BIRMINGHAM, ENGLAND.

From Glasgow I went to Edinburgh, the capital of Scotland. Edinburgh has an unusual and most interesting topography. It is built upon high hills intersected by deep ravines. The "Dean Bridge" crosses one of the deep ravines. The man who designed it was Telford, the originator of the Telford pavement, as we know it.

We are always interested in Hartford in trolley waiting stations, although we have not yet built any. They are quite common in European cities. They have a peculiar type of trolley waiting station in Birmingham. It is only about two and one-half feet wide by, perhaps, forty feet long, constructed with metal and glass windows on each side. In Birmingham they have some most interesting and satisfactory street signs. When I left for Europe I was prejudiced against the use of enamel signs, because they are liable to chip during cold weather. In Europe I found that about ninety-five per cent. of all the street signs were enamel. Most all have white letters on a blue surface. At Birmingham the most interesting part was the framework around the signs.

One of the funniest things to an American traveler is the double-deck trolley cars used in England and Scotland, which are operated left-handed. A man who comes from this country and who is used to dodging traffic in our streets and who understands the rule of the road, is apt to get confused by this fact. He must be cautious for the first few days. All of the cars are plastered with advertising signs. Some of the cars have the upper story open, and others are closed. It is surprising to see how readily and easily the people climb up and down the stairs to reach the upper story. In London the street traffic is one of the great problems that they have to deal with, and it would be almost impossible to get along without isles of safety. In a great many streets they are located not over one hundred and fifty feet apart.



ENAMELED STREET SIGN WITH ARTISTIC FRAME IN BIRMINGHAM, ENGLAND.

I was surprised to find a great amount of wooden block pavement in both English and Scotch cities. In London all of the streets subject to heavy traffic are paved with this material. These pavements, as a whole, are very smooth, and it is surprising to see how the horses get used to these smooth pavements. There are two reasons why the London horses stand up as well as they do on the smooth pavements; first, because screenings are thrown over the surface, and ground into it until the surface becomes gritty. This helps give the horses a foothold, although in general appearance the pavements are smooth; and secondly, the fact that all of the horses are smooth-shod. That is one reason why the pavements last so much longer. They are not cut up by the calks of the horses, and the horses become accustomed to sliding on the smooth pavements. It is not an infrequent sight to see a horse slide eight or ten feet when making a sudden stop. On the Strand, in London, there is probably the heaviest street traffic of any city in the world. The population of London is about seven million.

VIEW ON THE STRAND IN LONDON, THE HEAVIEST VEHICULAR TRAFFIC STREET IN THE WORLD.

I do not know what they would do in London without isles of safety, where the people can wait with their lives in their hands for a chance to cross the busy streets.

While the Londoners have become accustomed to aerial navigation, you never saw a more disgusted lot of fellows than they were when they woke up one morning and found that Bleriot, the Frenchman, had flown across the English Channel. Several attempts had been made, as you remember, by Englishmen to do this before but without success. Latham, I think it was, made one attempt to fly across the English Channel, but was unsuccessful.

INTERESTING VIEW AT SCAVENINGER, THE FAMOUS HOLLAND SHORE RESORT.

From England I went across the English Channel to the Hague, the famous city where the great peace congresses are held. As soon as you get across the English Channel you find the traffic is operated the same as ours is, by the right-hand method. You see no double-deck busses, trolley cars, or autos, until you arrive at Paris. One thing which interested me was the use of what are called "destination numbers" instead of signs, and the use of double-armed trolleys with a loop bearing on the trolley wire, so there is no trouble from the trolley pole jumping the trolley wire.

This view shows an interesting sight at Scaveninger the famous Holland shore resort. These little baskets, which are just large enough for one person to sit in, are spread all along the beach. The people go out there with their families and spend a whole afternoon, the mother or the lady in charge of the children sitting in one of these little baskets while the children build castles and fortifications and various other interesting designs in the sand. Then at night-time, when the water comes up upon the beach, the baskets are taken up to the quays.

When approaching Holland you will be impressed with one fact which stands out very clearly among other interesting sights, and that is the flatness of the country. You could play billiards all over Holland. Interesting windmills are located at frequent intervals. The whole country is below the level of the North Sea and the land would be of no use unless reclaimed. It has been reclaimed by the construction of an immense system of canals. The windmills are used to lift the water from the smaller canals, which are nothing more than ditches, perhaps four feet in width on the bottom, up to higher canals, and so on into the main carrier, which takes the water out to the North Sea. On a great many of these larger canals a large amount of transportation is carried on.

Amsterdam is one of the most interesting of the European ports. There is an immense volume of shipping done there annually. This (see page 12) is a view of one of the quays, showing the great warehouses rising up five stories in height.

These warehouses, in addition to being fireproof, are subdivided by fireproof walls. The cranes are run on rails, similar to a railroad car, the track for the cars passing underneath the framework so that the merchandise can be taken from a ship or from a railroad car and put on to a platform, or handled in the opposite direction, as may be desired.

This is the first advertising sign I saw which I thought had artistic merit. You will notice that it is built substantially with metal posts and framework. The city obtains quite a revenue from the rental of these advertising boards.

You will not be shocked after you have been in some of the European countries to frequently find about the streets what we

ONE OF THE QUAYS, HOISTING CRANES, AND FIVE-STORY WAREHOUSE IN AMSTERDAM.

ORNAMENTAL BILL BOARD IN AMSTERDAM.

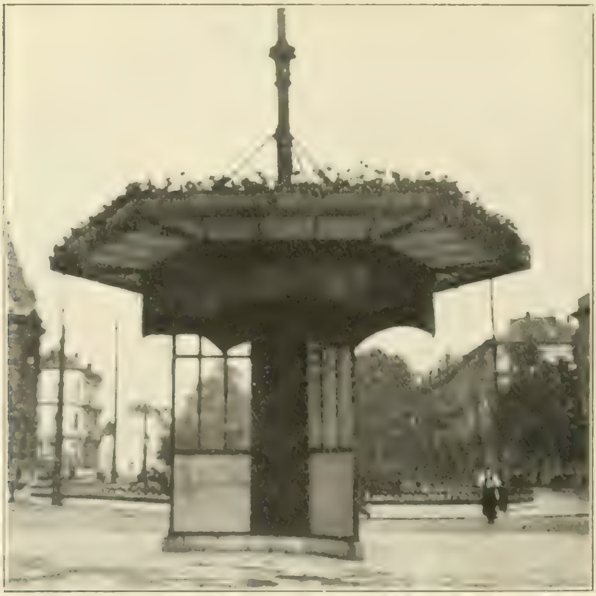
would call very obnoxious urinals. Here is one upon the principal street of Amsterdam leading from the business center to the railroad station.

If you really want to know what a dog's life is you want to be a dog in Holland for about a day. They are used in every conceivable way. Hundreds and thousands of them are used to help push small carts about the city streets. They are rigged up in all sorts of fashions, and the work that they do is marvelous. There are a great many milk carts around the streets of Rotterdam, and usually you will find a dog hitched to each one in some way to help push them around.

WHAT IT MEANS TO BE A DOG IN BELGIUM AND HOLLAND.

In the continental cities one finds a great many advertising kiosks. They use the various panels for advertising purposes. Advertising is much more restricted on the Continent than in England or Scotland, or in this country. The kiosks are frequently rented for the sale of newspapers, the person selling the papers occupying the inside. At night-time they are more or less illuminated.

SCENE IN ONE OF THE BUSY BASINS IN THE HEART OF ROTTERDAM.



USEFUL AND ARTISTIC TROLLEY WAITING STATION IN ANTWERP, BELGIUM—NOTE FLOWER BOXES ON EDGE OF ROOF.

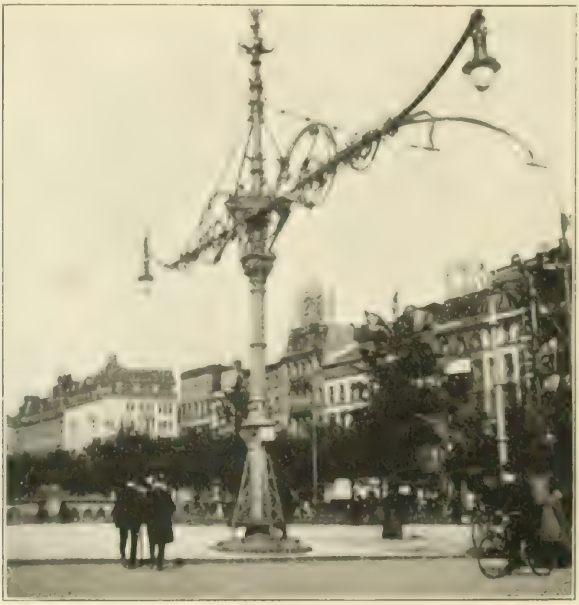
Here is another interesting sight,—of a trolley waiting station in Antwerp. You will notice it is constructed of metal and glass; around the edge of the roof are interesting boxes filled with flowers. These stations are used quite generally throughout Antwerp. The railroad entrance into Antwerp is very interesting, over an artistic and massive viaduct. They have recently built a great union station, and the approach was built in connection with the depot. Some of the specimens of ornamental tiling in connection with the viaduct are very interesting.

HIGH SPEED INTERURBAN ELECTRIC TRAIN ON QUAY, IN COLOGNE, GERMANY.

Brussels is the capital city of Belgium, and is not unlike Paris. It is said that this city imitates Paris to a very great extent. Brussels imitates Paris in the building of public monuments, fountains, statues, and street fixtures of such character.

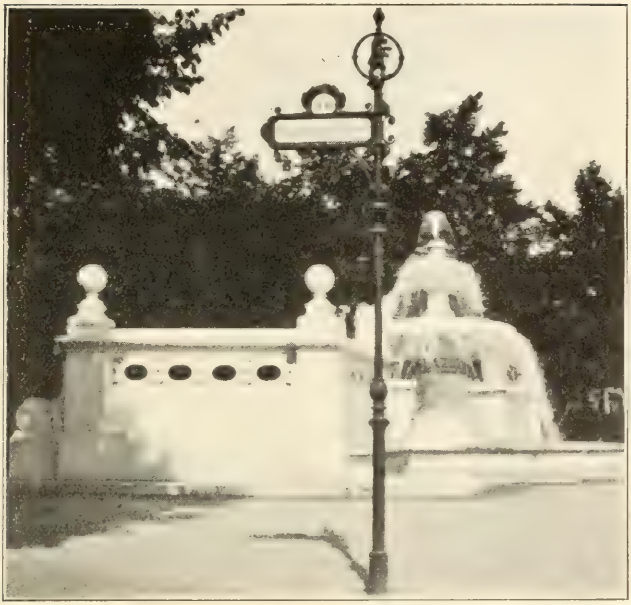
At Cologne, I had just time enough to take a snap shot of this interesting train and get off the track. This is a high-speed interurban train, which runs out quite a distance from Cologne. It is usually made up of very attractive cars, of white or cream color. The cars are quite similar to the Pullman cars here in America.

We have now reached Hamburg, and I want to say that Hamburg is one of the most artistic cities found in my travels. It is also a very progressive city. In fact, all of the German cities are very progressive; in my opinion, more so than those of any other nation. The Germans are very methodical from the civic standpoint, and are thoroughly imbued with the idea of keeping their cities up-to-date, and it is my opinion, they are far ahead of many other cities. France is considered one of the most artistic countries in the world, I suppose, but some of the things I saw in Germany lead me to the conclusion that Germany as a nation is just as far advanced.

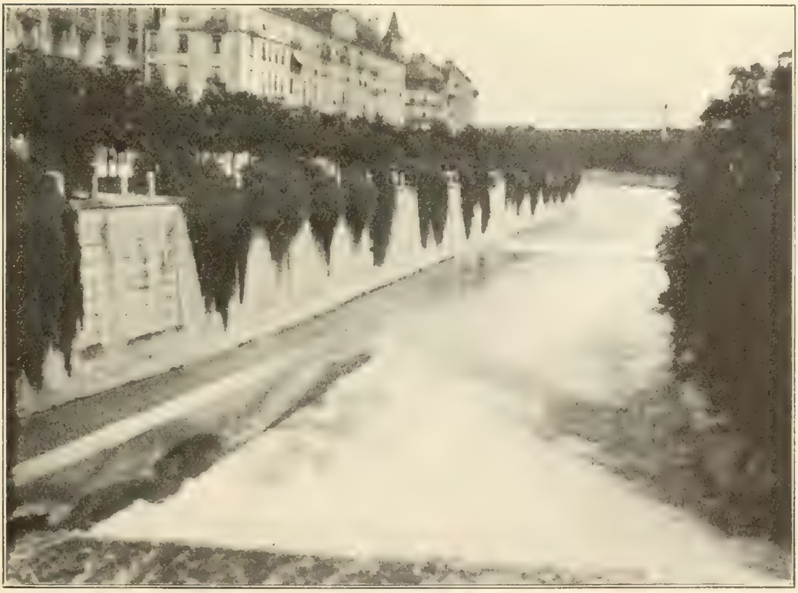


ARTISTIC COMBINATION—ELECTRIC LIGHT AND TROLLEY POLE IN HAMBURG.

The most artistic of all trolley and electric light poles I saw are these wrought iron ones in the heart of the city of Hamburg. Both ends of the long arm are carrying electric lights, and one end of the trolley wire. The people of Hamburg have widened what was formerly a small river into a great basin, known as the Alstu Basin, perhaps a fifth of a mile in width, and I should say



TYPICAL STREET SIGN IN BERLIN, MADE OF ENAMEL OR PORCELAIN WITH BLACK LETTERS ON WHITE BACKGROUND AND SET ON ARTISTIC STANDARD.



THE WAY RIVER BANKS ARE TREATED IN MUNICH, GERMANY.

two miles long. It is crossed by two or three railroad bridges, and the people enjoy and make use of this fresh-water basin. Boats of various kinds ply upon it, and you can make the trip around the whole basin for about three cents. At the upper end of the basin there are some very fine highways, on which are located the finer residences of Hamburg.

At Hamburg I saw many advertising kiosks made of red brick with green tile roofs and each contained a useful drinking fountain.

We now are in Berlin, the capital of Germany, and one of the most progressive cities on the Continent. The street signs in Berlin are made of enamel, but they are different from those in most cities from the fact that the letters are black, and the background is white. They have artistic frames, as you see in the view. The famous Unter den Linden is one of the handsomest streets in Berlin. I was disappointed with the street trees in Berlin because they were apparently not permitted to grow as large as they do in this country. I thought it was the fault of the trees, or that it was due to some particular kind of tree, but they told me that when a tree reaches a certain size and gets out of proportion to the width of the street and the scale of the buildings the tree is taken down and is replaced by another one, the whole idea being to produce and maintain a proper scale.

You have all read about the squegee street-cleaning wagon. In Berlin I saw several at work operating, one behind the other, on this famous Unter den Linden. At prominent street intersections in Berlin, many useful and artistic fountains are constructed.

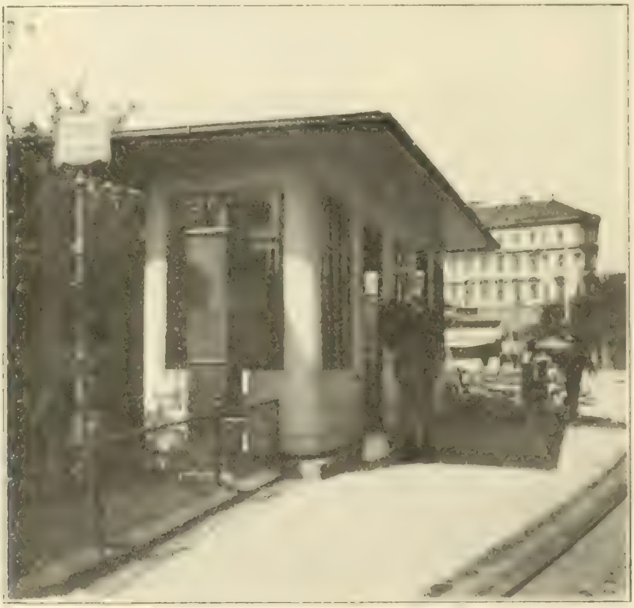
This view (page 17) illustrates the treatment of the banks of one of the principal rivers. I want to call your attention to the permanent and expensive walls constructed on either side, overhung with vines, etc. Some of the finest residences in Munich are located along the sides of the river. Before I reached Munich I learned that it was one of the cleanest cities in Europe and I was naturally interested to find out if this was true. The paved streets in the center of the city are cleaned by women, and they are good husky-looking specimens, I assure you. They do not loaf as much as men do. Notice their costumes, the heavy shoes, etc. The women in Munich also open the switches of the street railway company.

THE PAVED STREETS OF MUNICH ARE THE CLEANEST OF ANY EUROPEAN CITY—WHY? BECAUSE WOMEN CLEAN THEM!

TROLLEY CAR IN MUNICH SHOWING DESTINATION NUMBERS ON CAR TROLLEY POLES PASSED.

This picture, a trolley car in Munich (page 19), illustrates very well what I explained a while ago about the destination numbers on trolley cars. This view shows that car No. 4 passes the pole with a No. 4 fastened upon it.

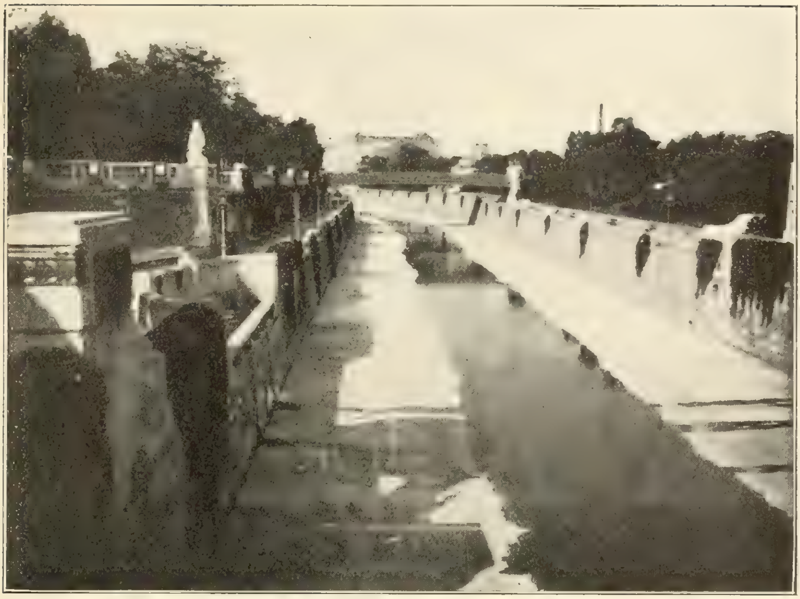
Vienna is said to be one of the best laid-out cities in Europe with the exception of Paris. Many artistic trolley waiting stations are used in Vienna.



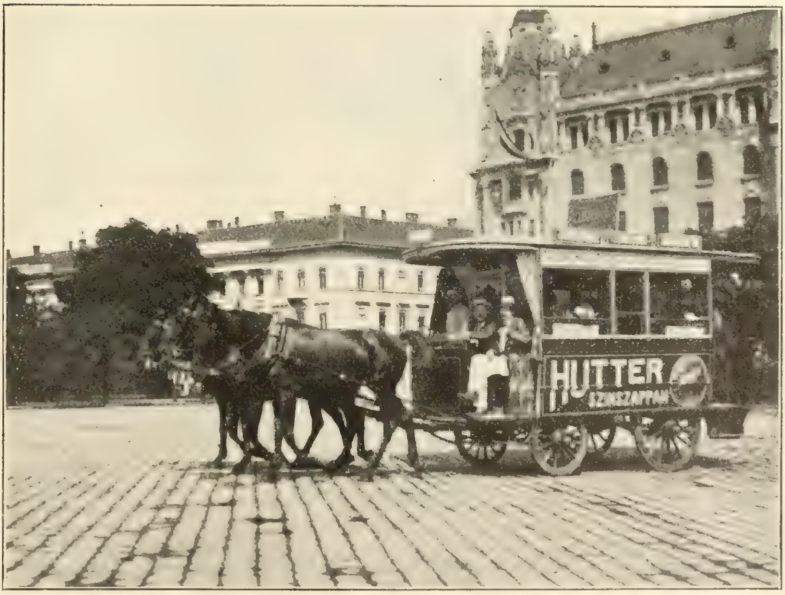
TROLLEY WAITING STATION MADE OF METAL AND GLASS IN VIENNA, AUSTRIA.

This view (page 21) shows the treatment of a river in Vienna similar to that shown in Munich. For a certain distance the river is treated in this manner, and then it passes into a conduit. At the time I was there the water in the channel was very low. The whole bottom of the canal was paved like a city street. At certain periods in each year the water would be pretty well up towards the top of the high retaining walls.

Budapest is one of the handsomest cities in Europe but some of its transportation facilities are crude affairs. From Budapest I went direct to Paris and was there about six days. I did not have enough time to really see Paris, but my general impression



ATTRACTIVE TREATMENT OF RIVER BANKS IN HEART OF VIENNA.



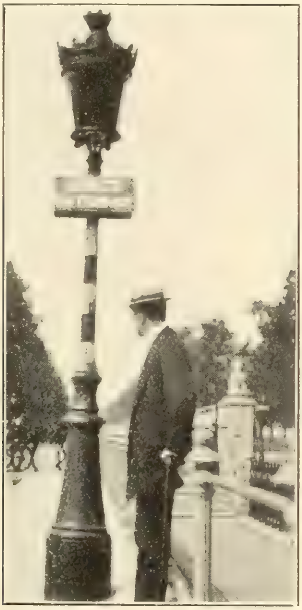
CRUDE METHODS OF TRANSPORTATION IN BUDAPEST, ONE OF THE MOST ARTISTIC CITIES OF EUROPE.

was that Paris does not come up to Munich and Berlin in cleanliness of the streets, or from a sanitary standpoint generally. Many automobile busses are used upon the principal streets of Paris, as there are no trolley cars in the center of the city. The public urinals in Paris are to an American rather objectionable. They are located at frequent intervals about the prominent streets.

PAUL WEYLAND BARTLETT'S FAMOUS EQUESTRIAN STATUE OF LAFAYETTE IN THE LOUVRE, PARIS.

Here is the famous Lafayette statue, the base of which was designed by Carrère & Hastings of New York, and the statue of Lafayette by Paul Bartlett, who was born in New Haven, and is rated as one of the best sculptors in the world to-day. He is doing a lot of work at Hartford on the north front of the Capitol, which is considered a great monument to his genius. The street signs in Paris are interesting and artistic. They are set at an angle with the pole, the idea being that the light above will illuminate the sign below at night-time. The signs have white letters on a blue background.

My return trip was made on the *Lusitania,* one of the fastest boats that cross the Atlantic. Of all the sights I saw in Europe the most interesting to me was the sight of the *Lusitania,* on which to make the home trip. The *Lusitania* on this trip established the enviable record of being the first steamer to cross the Atlantic in four days.



STREET SIGN ON LAMP POST IN PARIS—SIGN SET AT ANGLE WITH AXIS OF POLE SO LAMP ABOVE CAN ILLUMINATE IT AT NIGHT.

My European trip covered about twelve thousand miles. I passed through the custom house eleven times without a scratch, and crossed the English Channel four times. I was in Paris at the time of the aviation contest at Rheims, and an enthusiastic English flyer told me that the Atlantic ocean would be crossed by a flying machine within a year. In reply I told him if they did it in five years they would be "going some."

I want to say in closing that from the short study I have made of European cities, while they all have their striking characteristics as do most American cities, yet, as a whole, I do not think those cities are much ahead of American cities. So far as carrying on public work is concerned, we are far ahead of them. With the exception of their beautiful boulevards, and the character and location of their public buildings, we have many civic improvements which are superior to those in European cities.

PROBLEMS HANDLED BY THE TEST DEPARTMENT OF A LARGE CORPORATION.

By B. S. Hinckley, New Haven.

When we read in the daily papers of lives crushed out by falling structures of cement and steel, of trains wrecked by broken rails and axles, of automobiles and aeroplanes wrecked on account of failures of vital parts, the general public will remark, "How careless of the contractor or manufacturer to allow defective material to be used where life is at stake," although we, as engineers, realize that the greatest care may have been taken in the purchase and inspection of the material concerned in these specific cases.

Our life work and chosen profession is engineering, a most responsible office; for lives depend upon the accuracy of our determinations and the care with which we specify and purchase the material entering into our work.

Only recently has a Test Department been considered of any special value to the large corporations who, heretofore, have considered such a department one of expense only, and one not necessary to its commercial and financial success. To-day we rarely find a live railroad or manufacturing corporation without its department of tests—if not in name, in reality.

And the question arises, quite naturally, Why has this new department, this additional expense, been developed as a most essential adjunct and an added revenue earner for its corporation?

It is because such a department can handle the difficult problems concerning material and design, problems that require for their solution practical experience and theoretical knowledge combined.

Primarily the department of tests works hand in hand with the department of purchases, and in this one relation alone, the opportunity for demonstrating the value of such a department is unlimited.

The purchasing agent of a large corporation, no matter how extensive his experience nor how great his knowledge, can not be expected to know just what quality or grade of material is best adapted for use by his company.

Investigating as he does a thousand and one commodities, his purchases will range from pig iron to structural steel, from the cheapest rubber goods to the finest grade of sheet packing and fire hose, from the smallest tool to the large modern machine; he requires expert advice.

The basis of all the work of an analytical and testing laboratory is the preparation and execution of the specifications for the material under investigation. The preparation of specifications is therefore one of the problems handled by the laboratory. In this class of work it is of the utmost importance for the purchaser or consumer to bear in mind, that nothing should be embodied in the specifications for any material that will tend to increase the cost of that material to an amount over and above a price at which a satisfactory grade of the material under consideration can be purchased in the open market and taken from the reserve stocks of the large manufacturers of that material.

In other words, while the specification should be made sufficiently rigid to protect the purchaser from substitution of inferior or adulterated material, they should not go to the other extreme and place such restrictions on the method of manufacture that the manufacturer can not produce the goods without upsetting the ordinary routine of his daily operations, and adopt, or be forced to adopt, methods entirely foreign to his common practice.

There are many manufacturers and contractors by whom the word "specification" is uttered with a feeling of irony—the word leaves a bad taste in their mouths; they consider specifications unnecessary, discriminating, and very frequently unfair. The Engineering profession alone is responsible for this feeling, for the reason that so many specifications have been prepared without proper regard for the interests of the manufacturer or contractor and involve only the interests of the purchaser.

To illustrate this point; a certain contractor included in his specification for structural work a clause stating that the first coat of paint at the shop should be applied in a warm dry room at a temperature not less than 65 degrees F., a condition well nigh impossible, and hardly practical under present methods of fabrication.

Again,—a manufacturer of high grade hose sold several thousand feet of fire hose to a large corporation; this hose to be made to specification and delivered at destination before its acceptance. The manufacturer delivered the same made to conform exactly to the specification as he thought, and he was awaiting its acceptance and payment when he received word that his hose was rejected, as it did not fulfill the specification. He hastened to investigate, absolutely dumbfounded as to the cause. He was told that the hose was 50 feet and 1 inch in length over couplings, when it was specified to be delivered in 50 foot lengths. The outcome of the matter was that the manufacturer was compelled to take off one coupling from each length of hose, and make each length *exactly* 50 feet, although the purchaser was paying for only 50 foot lengths.

Certain classes of material can be more economically purchased on the basis of a guarantee that the material will give satisfaction for a certain period of time, than can be purchased under specifications; among such material we might name most rubber goods, including hose and sheet packing, paints and varnishes, and bearing metals.

In the case of rubber goods a vital feature of the specification would be the percentage of pure para rubber to be included in the mixture, and, in order to check this matter in the laboratory, it would be necessary to retain a chemist specially trained in that line of work.

In the matter of paints, experience has taught that the manufacturers of this class of material adopt methods which may readily conceal the makeup of their special brands, and for the same reasons it is impracticable to specify the ingredients required for the manufacture of high grade bearing metal.

It is well, wherever possible, to incorporate in the specification for a material a clause covering quick method of testing this material, to determine in a short period of time whether or no the material is satisfactory in quality.

The subject of this paper is so broad that we cannot give in complete detail the methods used in testing the various materials, and attempt will be made only to take up one or two features in each, which may be of special interest or which may not be so generally known.

Cement.

Very frequently shipments of cement are so delayed that the work at hand would be held up awaiting the results of the seven day and twenty-eight day tests, and for this reason a great many laboratories have adopted accelerated tests of various kinds.

Cement may be rejected on accelerated test as follows:—a pat of cement to be exposed in any convenient way in an atmosphere of steam, in a loosely closed vessel, for three hours and then placed in boiling water for three hours. It is required that the pat shall remain firm and hard and show no signs of distortion, checking, or disintegration. Experience has taught that where this portion of the specification is fulfilled there is rarely, if ever, any failure of the cement.

One of the great troubles experienced with cements of various brands is the shipment of so-called green cement, cement which has not had sufficient exposure and has not become sufficiently air-slacked.

Another most important feature in the testing of cement is the matter of fineness. The cementitious qualities of the cement are wholly contained in the very fine portions, and the granular and lumpy portions remaining after passing the sample through a sieve of 10,000 openings to the square inch have practically no efficiency in holding power.

Merchant Bar Iron.

In the mill inspection of bar iron and steel, where the specifications call for a certain limited tensile strength, great care must be taken in the selection of the test pieces.

Whenever possible, the test piece should be pulled as rolled, but should the capacity of the testing machine be insufficient, it is necessary to have the outer edge of the sample bar as one surface of the test piece. Therefore, with one machined surface an allowance is made on account of a certain loss in strength which is inherent in a rolled surface.

Further, in reference to inspection of bar iron, great care must be taken to examine very carefully the fracture of the bar when pulled apart on the testing machine. Refined iron should be free from steel. The presence of steel is readily discovered by segregated crystallization and a very small percentage would be ample

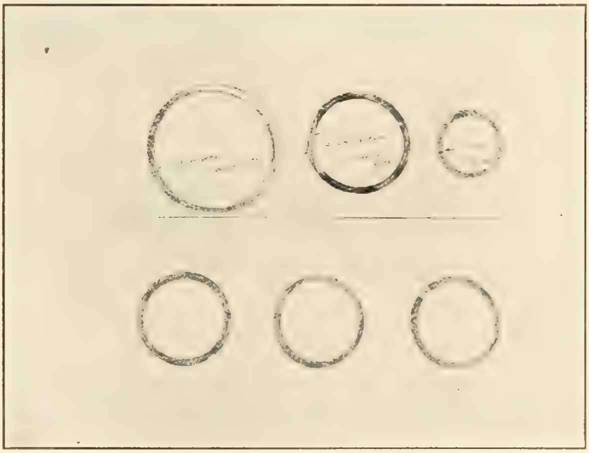


PLATE I

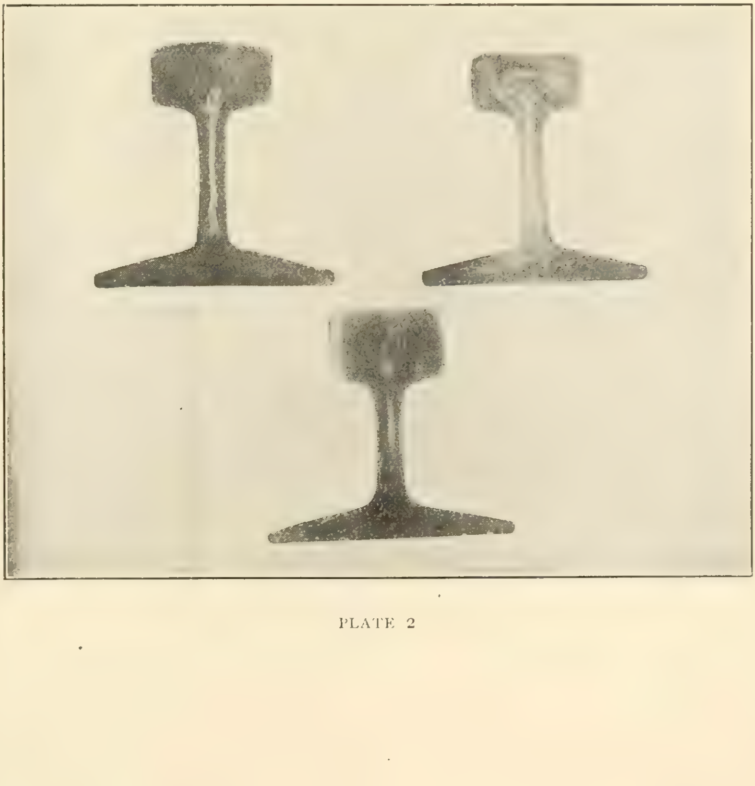


PLATE 2

grounds for rejection, although this is somewhat dependent upon the use for which the iron is intended. In order to determine the structure of iron or steel, etchings are frequently made. The section to be examined is first polished highly and then dipped in a solution of acid of the following ingredients,—90 parts water, 30 parts sulphuric acid, 10 parts hydrochloric acid.

After remaining in the solution from fifteen minutes to two hours a print is taken by the use of a coating of printer's ink. The results show distinctly the soft and hard places, show any seams due to improper working, bad welds in boiler flues; we can also determine the brand of staybolt iron, as the print will expose the typical method of piling used by the manufacturer.

An interesting point relating to the specification for iron and steel, which is at the present time still open for discussion, is making the elastic limit of greater importance than the tensile strength. It seems reasonable to suppose that where stress and strain have a constant relation one to the other up to a certain point, called the elastic limit—that this point would be an easy one to locate when operating a testing machine; such is not the case, however. Twelve test pieces were cut from the same boiler sheet and two pieces sent to each of six different mills, with request that their test department pull the pieces and send record of complete physical tests. The results showed that where the reports of the tensile strength from the six mills ran within 5 per cent. of the same figures the elastic limit varied 10 per cent. above and 8 per cent. below the average results. On this account care must be exerted as to the speed of operation of the testing machine whenever it is necessary to locate the elastic limit. Furthermore, should the elastic limit be incorporated in the specification for iron or steel, one might expect to have innumerable discussions between the consumer and the manufacturer. (See plates 1-5, pp. 29-32.)

Iron vs. Steel.

Protection of iron and steel from corrosion, due to atmospheric conditions and electrolysis, is an important problem. The protection is secured by means of tinning, galvanizing, painting, insulating, etc. and as research has demonstrated that iron is more capable of withstanding corrosion than steel, the importance of being able to distinguish quickly between a tinned and galvanized sheet as to the composition of the underlying metal, can readily be appreciated.

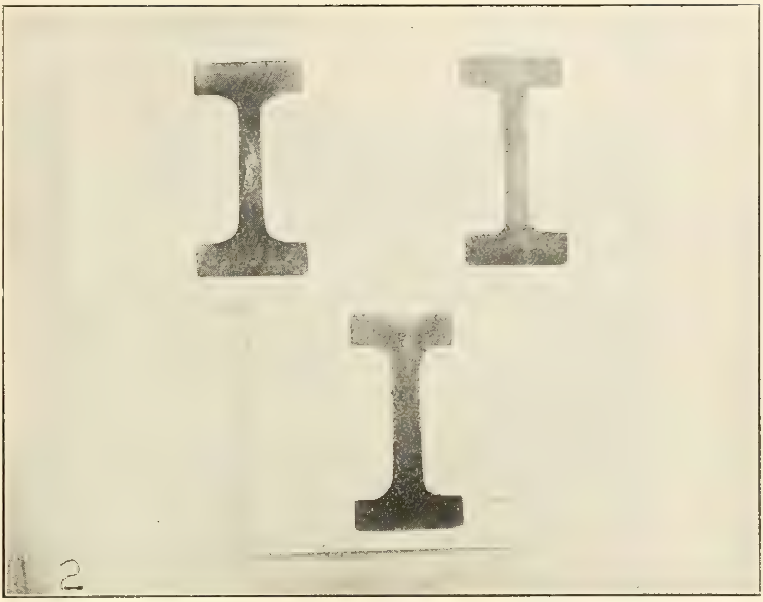


PLATE 3

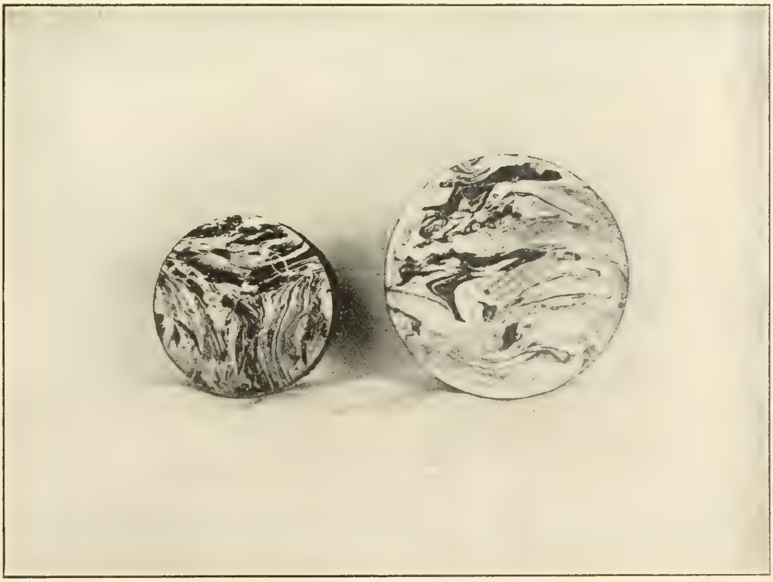


PLATE 4

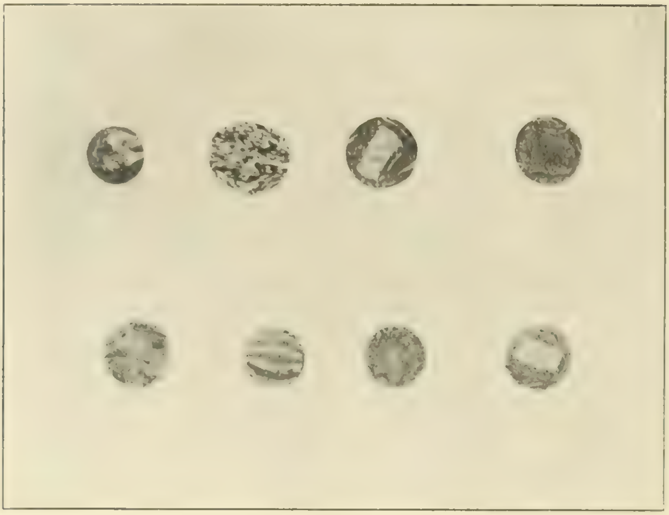


PLATE 5

Steel, as is well known, is iron with small proportions of carbon, phosphorus, sulphur, manganese and silicon, the combinations of these elements in varying proportions determining the quality of the steel. Their presence, particularly manganese, favors corrosion in the form of electrolysis and shortens the life of the metal in proportion to the exposure.

Iron, as considered in the same light, consists of a much purer form, there being but traces of impurities, particularly manganese, and owing to the difference in the working or manufacture the possibilities of segregation are less liable in iron than in steel. In the working of iron, such as charcoal iron, the separate fibers are incased in slag, which presumably aid materially in the protection from corrosion and electrolysis.

The elimination of manganese in iron makes it possible thus to detect quickly by simple test with a sheet or bar whether same is iron or steel. This test consists of dissolving a small piece of the metal in question in nitric acid and, after heating gently, adding some peroxide of lead, which immediately oxidizes the manganese to a permanganate, made characteristic by its high coloring power of a violet nature.

Steel Castings.

In addition to the customary tests to determine the tensile strength and elongation of steel castings, there is one most important feature regarding the inspection of these castings, and that is the annealing.

Steel castings, whenever used in service where the parts are subjects to vibrations, should be thoroughly annealed. The process of annealing renders the structure more homogeneous; the coarse large crystals are changed to very fine almost invisible crystals.

When investigating the failure of a steel frame of a heavy machine, we took a short section of the casting, and conducted the following test, to determine how much annealing, if any, it had received. The slab was heated to a white heat at one end; the other end being kept cold. In this way we had all temperatures from the temperature of the atmosphere to one above a proper annealing temperature. The bar was then allowed to cool slowly and afterwards broken open longitudinally. (See Plate 6.) The structure of the steel showed very coarse crystals at one end and a very fine structure at the heated end. And it was very evident that the steel castings had never been properly annealed.

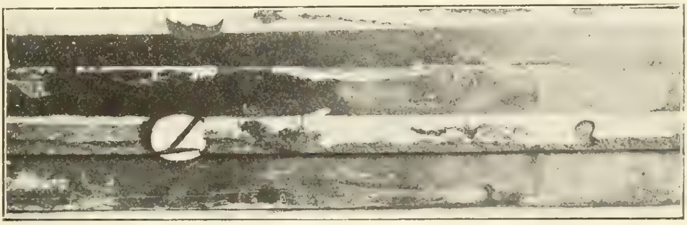


PLATE 6

A superficial examination will not always determine whether or no a steel casting has been annealed. Some careless manufacturers heat the castings to an insufficient temperature, giving the surface a reddish yellow appearance. To a novice it might appear that the casting had been annealed. Had the casting been heated to a temperature sufficient for proper annealing, the higher oxide of iron would give a deeper bluish and nearly black appearance to the outer surface.

Bearing Metals and Oils.

Bearing metals and oils may be tested with the same testing machine although both should never be tested at one and the same time. You will note in the illustration (Plate 7) two bearings equally distant from the pulley driving the shaft, the caps of each of these bearing boxes being easily removed to allow application of the test bearings, which bearings are of course cast of the metals under investigation. Delicate thermometers are inserted in openings in each box to show the temperature of the bearings, and careful record is taken of the thermometer readings at regular intervals and at varying speeds.

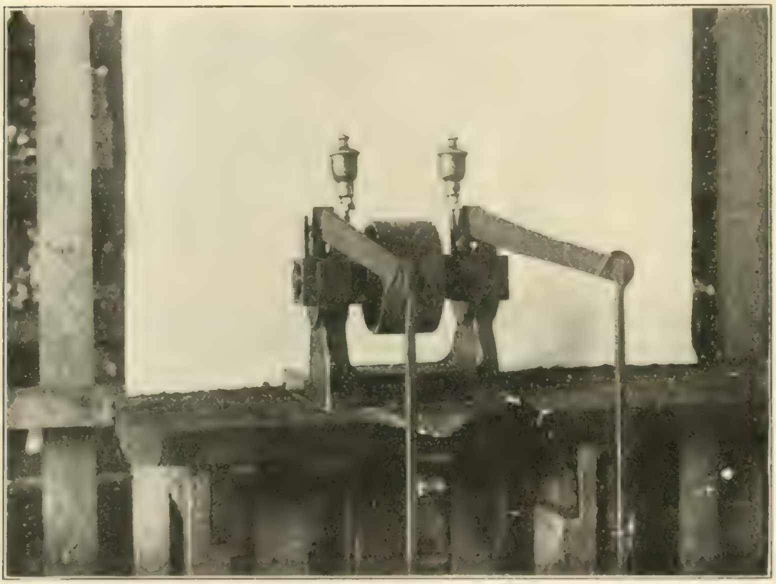


PLATE 7

The same amount and grade of lubricating oil is supplied to each bearing. Before the shaft is inserted the two bearings are reamed out with a standard reamer, which has been carefully ground to insure its boring a perfectly round hole and to make sure that the two holes are directly in line, one with the other.

Comparative efficiency of the two metals tested is secured, and, if desirable, a standard metal bearing may be adopted to which all others tested may be compared. The machine should be so carefully constructed that where the same metal is used in both bearings there should be only a fraction of a degree difference in temperature between the two. Taking a center line through the machine, it is necessary to have the one side perfectly insulated from the other to prevent any passage of heat from one bearing to the other.

The nature of the construction of the machine is such that service tests may be made of lubricating oils by using bearing metals of like composition.

Coal.

In this era of attention to the conservation of the country's natural resources, the economical mining, handling, and consumption of coal is receiving its due share of investigation. Many large consumers are purchasing this commodity on specification, the fundamental basis of which is the required British thermal unit value of the coal. A high grade bituminous coal should contain approximately from 14,000 to 15,000 British thermal units in each pound.

To determine the British thermal units requires calorimeter tests, and various types of calorimeters are on the market, some of them worthless, on account of the large errors liable to occur in their operation. Great care must be used in the sampling of the coal under investigation, as the small amount of one gram only is used for the British thermal unit determination, and another gram for the analysis, and these very small portions must be representative of the full shipment, which may sometimes amount to seven thousand tons.

Two methods of analysis are often used in examination of coal, namely, the approximate and ultimate. The approximate is the method usually followed. This analysis consists in obtaining the moisture, volatile matter, fixed carbon, ash and sulphur upon a sample of finely powered coal.

The percentage of ash in a coal governs largely the commercial value, but strange as it may seem, a coal high in ash may under certain conditions contain more heat units than one lower in ash. This may be caused by the first coal (high ash coal), containing less free oxygen than the second (low ash coal). In other words, the presence of free oxygen is just as objectionable as the presence of ash.

The United States Government has investigated this matter extensively and I would refer you to Bulletin No. 382 of the United States Geological Survey.

Boiler and Plant Tests.

It devolves upon the test department of any corporation operating a power plant to check the efficiency of such a plant both as regards boiler and engine economy. The department follows up the tests made, with recommendation for changes in design or methods of operation which may reduce the losses. Too many expensively operated power plants are considered a side issue by the management, and no attention whatever is given to their operation beyond the yearly consideration of fuel supply.

We are all familiar with the usual methods of conducting boiler tests. An important feature often overlooked is the analysis of the flue gases, for in this way only can the process of combustion be intelligently and effectively followed up. The products of combustion, important in this connection, are carbonic acid gas (CO_2), carbon monoxide (CO), and oxygen (O), which are readily determined by means of absorption pipettes, embodied in the present up-to-date, compact, portable apparatus known as the Orsat. The operation consists of the passing of a measured volume of gas, carefully collected, successively, through caustic potash, alkaline pyrogallol and cuprous chloride solution for CO_2, O and CO respectively. The proportion of these gases, one to another, in the sample brings out clearly the defects in firing, leaks in boiler setting, etc. An investigation of this sort will greatly assist in determining the most desirable draft—whether it shall be forced, natural or induced.

Capable men available as firemen to-day are scarce; efficient firing is therefore seldom obtained, and actual tests have shown that mechanical stokers if installed will often increase the boiler capacity and will eliminate the necessity for the installation of additional boiler units.

At one plant the mechanical stoker was working at a high speed; the coal was being fed so fast that it was necessary to increase the forced draft; and even then a great deal of coal was wasted as unconsumed coal in the ash pit and in the form of smoke. It was suggested that a larger pulley be used on the driving shaft of the stoker, thus reducing the speed. This was done, and as a result the draft was reduced and a large reduction made in fuel consumption.

Creosoting of Ties and Timber.

In order to conserve the forests and timber supply, the treatment of ties, timber, and poles has largely increased in the past few years. The proper treatment is a matter of laboratory investigation as well as practical experimentation.

Chestnut timber, the prevailing timber of the State of Connecticut, can not be treated in the same way that most other woods are treated. To secure the best results, ordinarily the timber is allowed to season for six months before being placed in the retort, but it is necessary in the case of chestnut to treat it when green.

Two seasoned chestnut ties were shipped to a creosoting plant in the south and orders were given to treat them by the same methods that are used in the case of long leaf yellow pine. The results were that the ties were nearly rent open from end to end, having cracked open on application of the creosote oil. On treatment of green chestnut ties, however, the results were successful. The penetration of the creosote oil must be thorough and strike the innermost cells,—this in order that the antiseptic may kill the fungi and germs and prevent decay from the interior.

Experiments with the use of zinc chloride in the place of creosote oil have shown that the zinc chloride is only efficient in the arid districts, as the moisture in the air and the rain will cause the chloride to leak out gradually, until the wood is left in its natural and untreated state.

Should creosoted wood material be ordered on contract work, it should be specified that a certain weight of creosote oil to the cubic foot of timber shall be injected into the wood, the amount of oil varying according to process used, and that it should penetrate throughout the section. Experiments should be made by breaking open paving blocks or sawing off sections of ties or poles, and, from laboratory determinations, by process of elimination, the actual percentage of oil injected can be determined quite accurately.

Service Tests.

Theory and technique should never be allowed to take precedence over practical experience and service tests. The latter are as important as the former, and in a great many problems it is the practical service test that derives the solution. The selection of the most efficient high speed tool steel from among numerous samples submitted in competition will demonstrate this statement.

Chemical analyses may be made of each; some may show presence of vanadium, some may show tungsten, others may show titanium, and all will show their respective percentages of carbon and manganese, but how can the most efficient be selected from these results alone? It is quite evident that this would be impossible.

From a bar of each steel submitted, a tool is forged and hardened under the direction of a representative of the steel manufacturer, all the tools to be made for service in the same machine and, as near as possible, on the same quality of material. Careful records must be made of the depth of cut, the feed, the cutting speed, the weight of material removed, the number of times the cutting edge breaks, the number of times the tool requires grinding, and the time the tool is in actual service.

It is by this practical test only that a proper selection can be made.

Routine and Records.

It is quite necessary that a test department, at all times, keep check on material which is received daily and used in large amounts. This is done to make sure that the quality of the material received on the various orders is up to specifications, if bought to specifications, and of a quality equal to that of samples submitted for preliminary test, if not bought to specification. It is always well and quite important to retain in the laboratory standard samples of any material for which the company has no specification—this standard sample to represent the grade and quality of the sample submitted on bid and before actual purchase is made.

To illustrate this point: a purchasing agent may order a car-load of fire-brick from a manufacturer, advising him that the brick may be watched carefully for results upon which will depend duplication of the order. This car-load will no doubt make good, and it may also happen that future shipments will not be of equal quality. If it is not the special duty of someone to follow up this brick and keep records of the service secured, there would be no complete record, and unless the brick was very poor, the purchasing agent would probably hear nothing and would naturally suppose he was receiving an A No. 1 grade, whereas his company would be receiving a second grade fire-brick.

Another instance along this line: A sample of rubber sheet packing was given a heat test to determine the effects of the heat at a temperature corresponding to the pressure to which the packing would be subjected when in service. The results were satisfactory for this sample, but on receipt of regular shipment later on, other samples representing the shipment were selected and, on being subjected to the same test, failed.

Scope of Work of Test Department.

In addition to the testing and analyzing of ordinary materials used in construction and manufacture, the test department of a large corporation is the receptacle of all sorts of problems of a technical nature. It might be called upon to investigate and make report of the value of some patent device, a source of supply of raw material, an improvement in the method of manufacture, either from a chemical or mechanical standpoint, location of a water supply for the power plant, etc. The work is of the broadest nature and to be properly conducted necessitates the employment of men trained in the several branches of engineering in addition to chemists, geologists and biologists.

THE HAMMOND MINING AND METALLURGICAL LABORATORY OF THE SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY.*

By Louis D. Huntoon, New Haven, Conn.

Gentlemen, this paper has been published in the Institute of Mining Engineers. I have some copies of it here which you can obtain. I am simply going to run over one or two of the items in it covering the erection, cost, floor area, etc., and then show you what the building looks like from lantern slides before the inspection.

The Hammond Mining and Metallurgical Laboratory is the gift of Prof. John Hays Hammond to the Sheffield Scientific School of Yale University. Professor Hammond was graduated from this school in the class of 1876, and has always shown great interest in its welfare and progress. In 1903, he offered to build and equip for it a mining and metallurgical laboratory. This offer was gratefully accepted by the trustees; and in October of the same year the architect, W. Gedney Beatty, and the writer were employed to draw up plans for the building, which is the largest of its kind in this country.

The Treasurer's report shows the total gift of Professor Hammond, including land, building, and equipment, to have been $128,741.53. This does not include $5,000 given by Professor Hammond to defray incidental expenses. The detailed cost of the machinery and installation included in the above sum is as follows:

Machinery	$9,846.00
Pipe and fittings	925.05
Hangers, shafting, pulleys, belts, etc.	357.83
Steel work, tanks, launders, etc.	272.10
Screens for sizing, etc.	411.37
Lumber	1,806.36

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* Reprinted by permission of the American Institute of Mining Engineers.

General Supplies:		
Hardware	$135.96	
Tools	263.66	
Paints	204.63	
Electric and incidental	439.57	$1,043.82
Machine-shop material	259.44	
Labor	722.29	981.73
Foundry-work, castings, etc.		346.84
Freight, carting, and teaming		397.38
Foundations, labor, and material		1,257.37
Labor, construction, and installation		9,355.09
General expense		314.96
Total		$27,405.99

REQUIREMENTS OF THE LABORATORY.

Before planning the building the mining-laboratories and ore-testing plants in the East were visited, and blue-prints of the Western and Canadian mining-laboratories were studied carefully. The methods of instruction and laboratory-work required of the students at different mining-schools were also carefully compared. After the completion of this preliminary work it was found that the equipment and laboratory-work required were different in the several universities, and that the design and equipment of the Hammond Laboratory would depend entirely upon the requirements placed upon it. A consultation with Professor Hammond resulted in the decision to erect a building to fulfill four requirements.

1. Teaching of the theory and practice of assaying, metallurgy, mining, and ore-dressing.

2. Testing of ores on a small scale to determine the most economical method of treatment.

3. Handling of ores on a commercial scale in order to verify the results obtained from the preliminary testing.

4. Research-work and investigations by the instructors or by professional men to develop new processes or perfect new machines.

The first requirement called for lecture-rooms and lecture-tables fitted with gas, water, and electric power for class-room experiments; also a museum for mining- and metallurgical models and the products of mills and smelters.

The second requirement, space for small ore-testing machinery.

The third requirement, space for full-sized machines, and floor-space for the installation of new machinery without changing the proposed arrangement.

The fourth requirement, and the most important for the advancement of the profession, space equipped with power, gas, and water for investigations on a large or small scale.

ERECTION OF THE BUILDING.

The building was designed with the above objects in view, and the plans accepted in May, 1904. The building-contract called for the building and the furnishings for the library, lecture- and research-rooms, and also the desk-rooms for assaying and ore-testing. Ground was broken in June, 1904, and the building was ready for occupancy in November, 1905. During the autumn and winter of 1905 the assay-furnaces and small ore-testing machines were installed, and the supplies for the department of assaying were purchased. The first course in assaying and ore-testing was given the following spring. While this work was in progress, museum-cases and the balance of the furnishings were designed and built, and plans were drawn for the arrangement of the ore-dressing machinery, the order for which was placed on July 1, 1906, with the Allis-Chalmers Co. The first delivery of machinery was made in October, 1906, and in January, 1907, the first rock was broken in the crushing-room. In June the mill-wright, A. A. Watson, completed his work, and the first ore was milled during that month.

The building has a frontage of 84 ft. on Mansfield Street, and a depth of about 200 ft., extending back to the Northampton Division of the N. Y., N. H. & H. R. R. The detailed dimensions of the various rooms can be derived from the plan, Fig. 2. The lot upon which it is placed has a frontage of 100 ft. The railroad company built a siding at the rear of the building for the delivery of ores.

The building is constructed of fire-proof materials throughout, consisting of granite, limestone, brick, concrete, and steel. All exterior walls are lined with hollow brick, which was coated, before plastering, with anti-hydrene. The ground floor of the entire building is of cement, 5 in. thick. All steam-, gas-, water-, and electric conduits are exposed. The roof of the building, consisting of terra-cotta book-tile covered with slate, is supported by heavy iron trusses.

DESCRIPTION OF THE BUILDING.

A view of the Hammond Mining and Metallurgical Laboratory is given in Fig. 1. Figs. 3 to 12 are views of several of the rooms and of portions of the equipment of the building.

The ground floor of the building is divided into three portions. The front portion consists of a basement and two floors. The floors, built of steel, hollow brick, and concrete, are divided into various rooms by partition walls of hollow brick. The stairs connecting the floors are of steel with slate steps.

The second or laboratory portion of the building, adjoining the front portion, was designed to furnish as much light and air as possible, allowing for an increased floor-area. The side-walls are 27 ft. high, and the roof in the center of the building is 44 ft. high. In the center of the roof, for ventilation, there are monitors with sash windows on each side, which are opened and closed by gearing and chains extending to the floor. The windows in the side-walls are 5 ft. apart and are 20 feet high by 5 ft. wide. These windows are divided in the center for the building of mezzanine floors along the outside walls as soon as the increased floor-area is required. Around the windows are steam-coils for heating, and from the roof-trusses are suspended arc-lamps for lighting. Between the windows and every few feet along the transverse walls are incandescent-lamp outlets, to which lamps can be attached to provide light for inspecting the machines.

This portion of the building is subdivided by two transverse walls into three rooms, having a total floor-area of about 12,000 sq. ft., which can be increased 10,000 sq. ft. by building the mezzanine floors planned. Eight chimneys were built in the transverse walls, two of which are lined with fire-brick. The floor of the large room slopes to a central sump, 12 ft. square by 3 ft. deep, with 12-in. concrete sides and bottom. The floor of the sump slopes to a depression in one corner, which has a connection with the sewer, controlled by a gate-valve. In order to prevent the seepage of water into the sand under the building, the sump was lined with several layers of tarred paper and felt, held together with hot tar and covered with cement. The sump is connected with the main water-supply, and a pump is

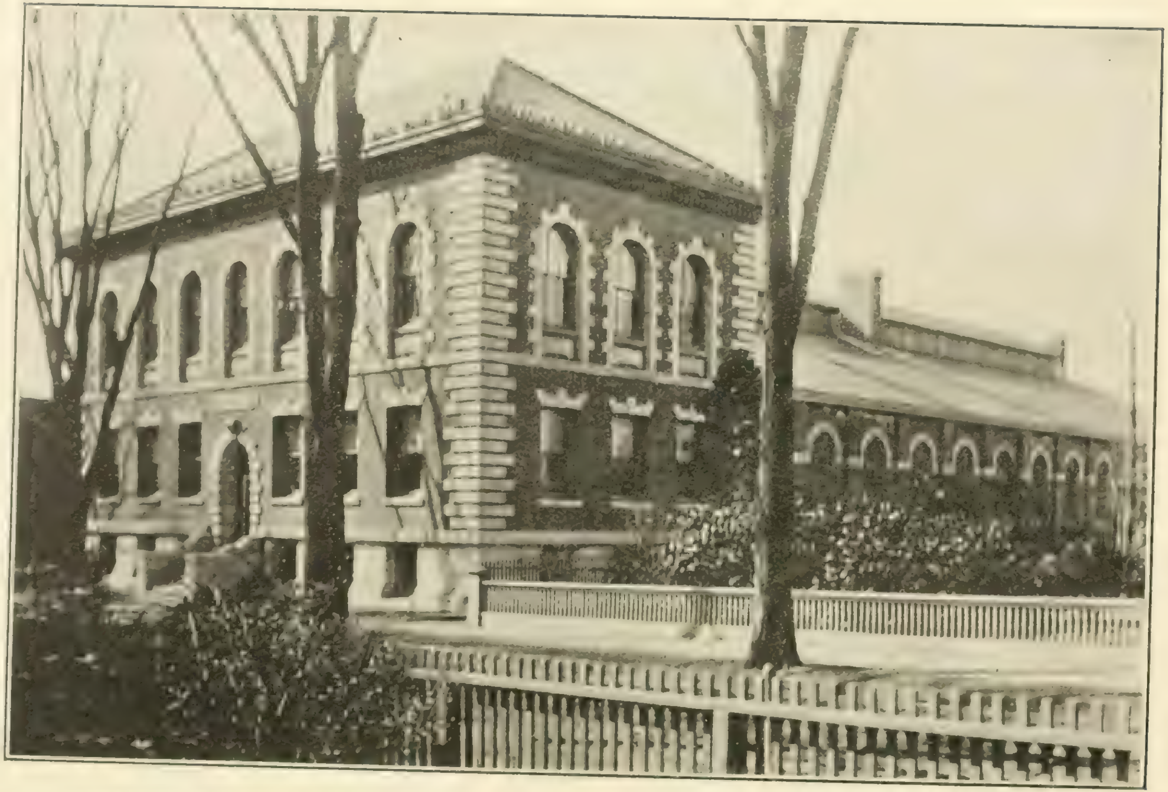


FIG. 1.—HAMMOND MINING AND METALLURGICAL LABORATORY, SHEFFIELD SCIENTIFIC SCHOOL, YALE UNIVERSITY, NEW HAVEN, CONN.

provided to enable the water to be used to supply the tank on the top floor. The floors in the other rooms are horizontal, with the exception of the space devoted to ore-testing, which slopes to open drains. In buildings of this character it would be better to have all the concrete laboratory-floors slope to an open drain for convenience in washing. Some of the concrete floors have been painted and others oiled to prevent dust from the surface-wear of the concrete. Both methods have proved satisfactory. The paint gives a much better appearance but requires a repainting, whereas the oil shows no wear.

The third portion of the building is triangular, conforming to the shape of the lot. It is divided into an upper and a lower floor: the former, a crushing-room; the latter, a boiler-room for steam-heating and a repair-shop.

LIBRARY, MUSEUM, ETC.

The front portion of the building is devoted to the library, museum, lecture-rooms, and research-rooms. The first floor contains the library, museum, and office.

The library, to the left of the hall, has two windows facing east and two facing south. The room is furnished with shelves and two large tables, lighted by individual electric lamps and a ceiling cluster.

The museum, across the hall from the library, has six windows. This room contains museum-cases and chests of drawers for student collections. It is intended to place in the museum typical flow-sheets of mills, and in the cases and drawers the various products from these mills. This arrangement will assist the student in studying the practical handling of ores from various districts. Here also will be placed models and photographs of mining-, metallurgical, and milling-plants and machinery.

The office is connected with the library and the hall.

Between the office and the museum and directly in front of the entrance are a hall-closet and an office-closet. Ultimately these closets will be used as a hallway connecting the entrance-hall with the mezzanine floors to be built later in the second or laboratory portion of the building as soon as this extra space is required.

On the second floor are two lecture-rooms, an instructor's room, and a hall-closet. Both lecture-rooms are furnished with

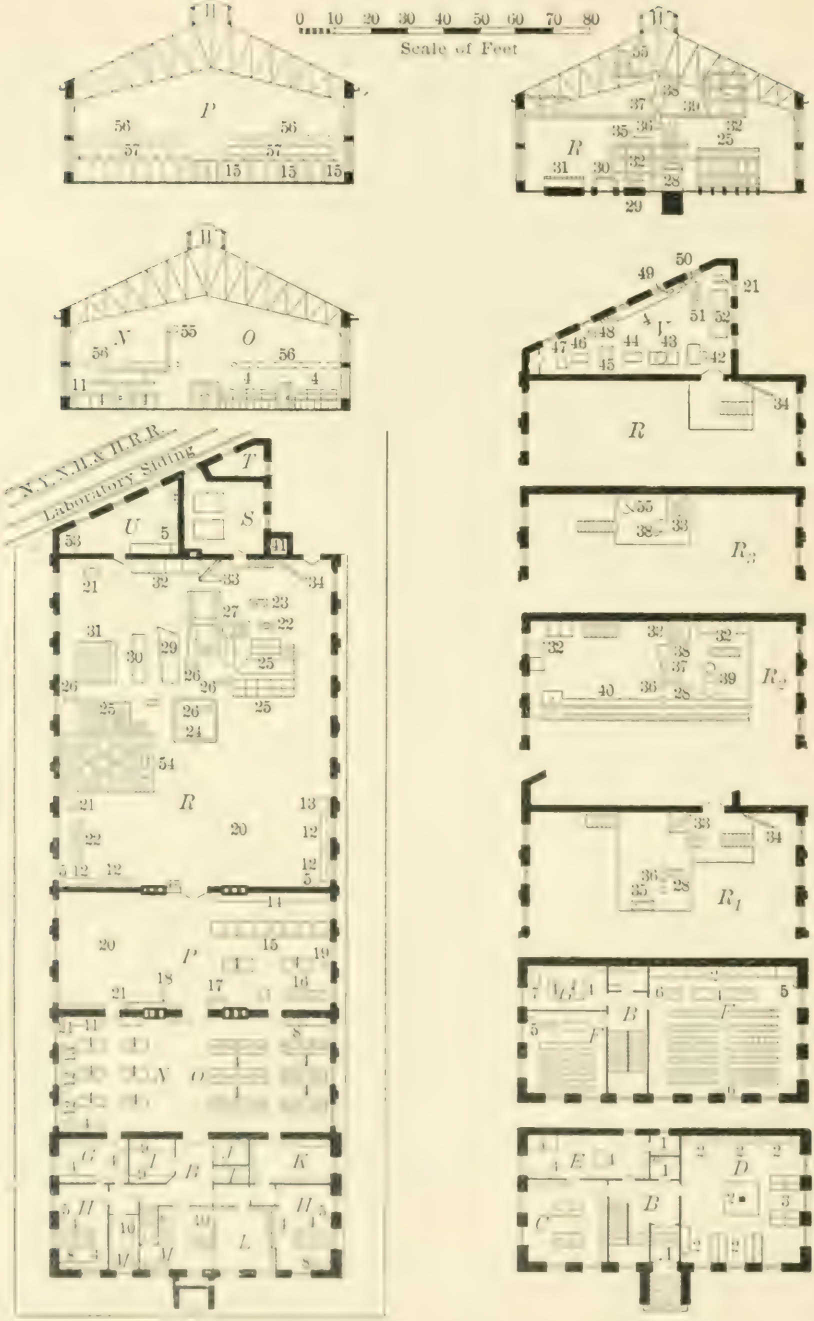


FIG. 2.—FLOOR-PLANS AND SECTIONS OF THE HAMMOND MINING AND METALLURGICAL LABORATORY.

ROOMS AND APPARATUS OF THE HAMMOND MINING AND METALLURGICAL LABORATORY.

Rooms.

A. Entrance.
B. Hall.
C. Library.
D. Museum.
E. Office.
F. Lecture-rooms.
G. Instructor's-rooms.
H. Research-rooms.
I. Supply-rooms.
J. Dark-rooms.
K. Balance-rooms.
L. Locker-rooms.
M. Lavatories.
N. Ore-testing room.
O. Assay-desk room.
P. Furnace-room.
R. Milling-room, ground floor
R.$_1$ Milling-room, first floor.
R.$_2$ Milling-room, second floor.
R.$_3$ Milling-room, third floor.
S. Boiler-room.
T. Coal-storage.
U. Repair-shop.
V. Crushing-room.
W. Monitors.

Apparatus.

1. Closets.
2. Glass cases.
3. Drawer-cases.
4. Desks.
5. Electric-power switches.
6. Electric lantern.
7. Electric blue-print frame.
8. Chemical hoods.
9. Shelves.
10. Showers.
11. Five Vezin jigs.
12. Steam driers.
13. Gas driers.
14. Coal-bins.
15. Soft-coal furnaces.
16. Gas-furnaces.
17. Crucible-furnaces.
18. Roots blower.
19. Bullion-rolls.
20. Space to grow.
21. Motors.
22. Amalgamating-pans.
23. Clean-up pan.
24. Sump.
25. Harz jig.
26. Centrifugal pumps.
27. Huntington mill.
28. Five-stamp battery.
29. Wilfley concentrator.
30. Frue vanner.
31. Wilfley slimer.
32. Ore-storage bins.
33. Platform-elevator.
34. Crane.
35. Hydraulic classifiers.
36. Trommels.
37. Vezin sampler.
38. Challenge feeders.
39. De-watering-cones.
40. Main line-shafting.
41. Ash-pit.
42. Blake breaker.
43. Gyratory breaker.
44. Dodge breaker.
45. Rolls.
46. Abbé pebble-mill.
47. Krupp ball-mill.
48. Sample-grinder.
49. Case breaker.
50. Abbé jar-mill.
51. Power bucking-board.
52. Shaking-screen.
53. Main switch-board.
54. Cyanide-plant.
55. Water-tank.
56. Proposed mezzanine floors.
57. Furnace-flues.
58. Proposed furnaces.
59. Laboratory R. R. switch.

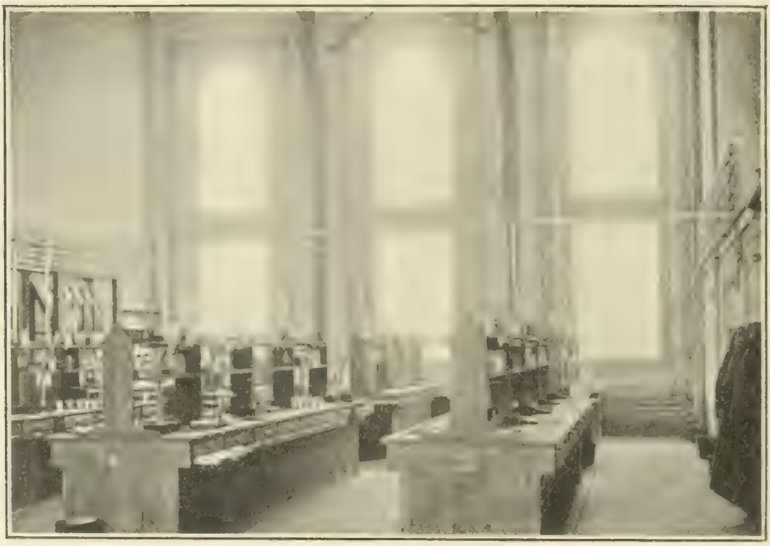


FIG. 3.—ASSAY-DESKS.

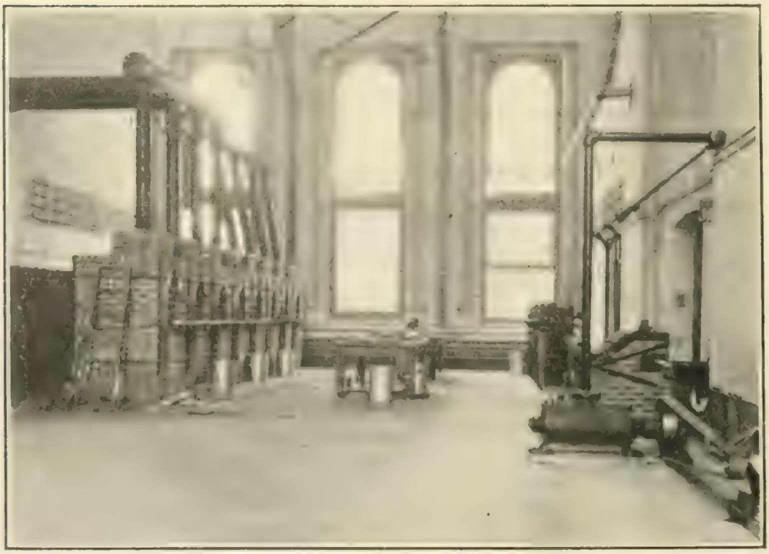


FIG. 4.—FURNACE-ROOM.

chairs on stepped floors, lecture-tables fitted with gas-, water-, and electric-light connections, and an electric switch for power. The rooms are ventilated through a grating in the ceiling which connects with a sky-light in the hall closet.

The large lecture-room can accommodate 112 students. The lecture-table, 18 ft. long, contains large flat drawers for charts and maps. Back of the lecture-table are eight museum-cases with closets below. The four central cases have sashes of slate for black-board work; the four outside cases have sashes of glass. There are also two connections for a lantern, one at the side of the lecture-table, the other in the rear of the room.

The small lecture-room can accommodate 45 students.

The instructor's room at present contains an electric blue-print frame and drawing-tables.

The basement, on the ground floor of the building, is subdivided into research-rooms, supply-rooms, locker-rooms, shower-baths, and lavatories, all heated by steam-coils suspended from the ceiling, and lighted by ceiling-clusters.

The two corner rooms are devoted to research-work. These rooms are furnished with desks, hoods, and electric power-plugs for power or electric-furnace work. Each room is lighted by three windows, individual electric lights on the desks, ceiling-clusters, and extra light-outlets in the walls for special work. The desks are equipped with water, gas, and electricity.

Adjacent to the southeast research-room is an instructor's room, equipped with desks for use in assaying. This room connects with the central hall and assay-laboratory. The students' samples for assaying are stored in this room, together with the assay-records.

Adjacent to the northeast research-room is the balance-room, connecting with the assay-laboratory. The room is equipped with nine Becker button-balances, two Keller button-balances, and one Becker analytical-balance. Light is furnished by one window, and each balance has an individual electric light.

The supply-room and dark-rooms are interior rooms connecting with the central hall. The supply-rooms contain shelves and drawers. The dark-room is furnished with a slate desk, water, gas, electric-lights, and an exhaust-fan for ventilating.

The students' locker-room, for changing clothes, is in the front of the building, connecting with the central hall. This

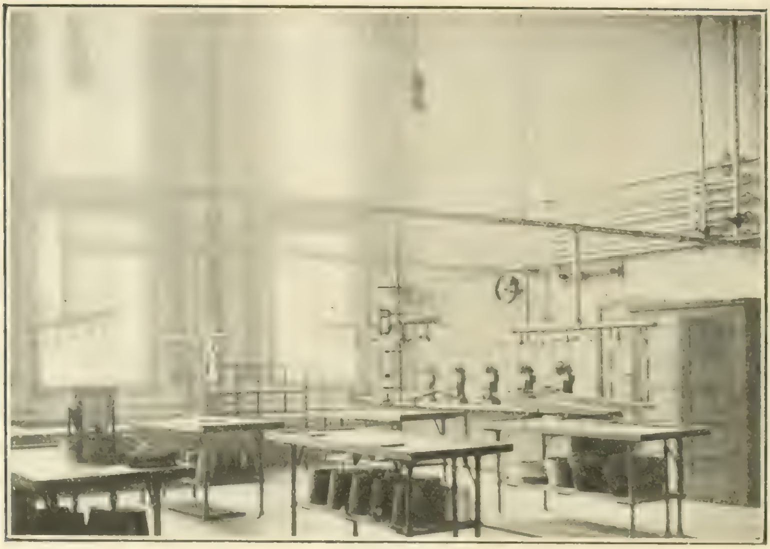


FIG. 5.—ORE-TESTING LABORATORY.

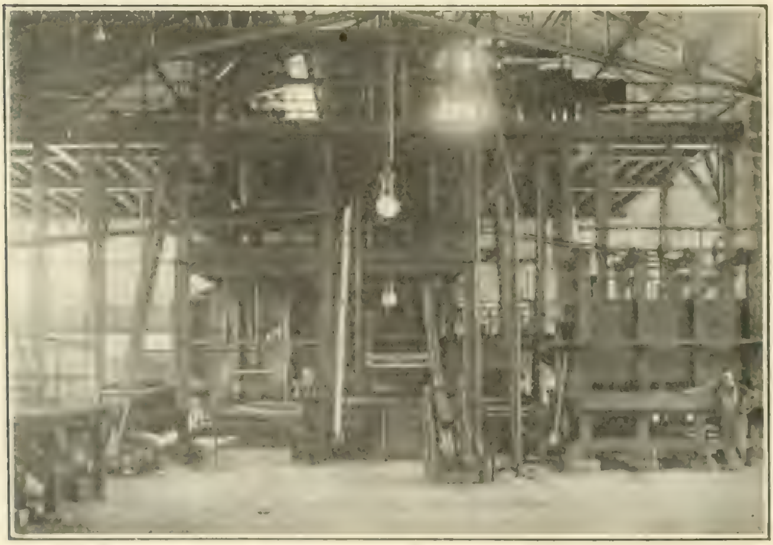


FIG. 6.—CONCENTRATING MACHINERY.

room can accommodate 80 lockers, 56 of which have been already built. Connected with the locker-room are two shower-baths and a lavatory.

The instructors' lavoratory contains lockers and a shower, connects with the hall, and is adjacent to the southeast research-room. Hot water is supplied to the showers from a Rudd automatic gas water-heater.

ORE-TESTING LABORATORY.

The first laboratory-room, entered from the basement hall, is devoted to ore-testing and assaying. The equipment on the south side of the room, for ore-testing, consists of eight working-tables covered with linoleum, and furnished with open drains to the floor. Above the tables are water-pipes furnished with dial-plug-cocks leading from a reservoir on the wall, whereby a constant pressure is maintained. Adjacent to the windows are one gas and two steam driers. The apparatus installed consists of five Vezin jigs, five glass classifiers, three Munroe tables, sizing-screens, gold-washing and amalgamating-pans, *bateas,* and accessories necessary for the testing of ores.

ASSAYING- AND METALLURGICAL LABORATORY.

On the north side of the first laboratory-room, 18 assay-desks were installed when the building was completed, and last summer 24 more, making a total of 42. The original desks were covered with slate and contained lockers, drawers, shelves, and desk-lockers for pulp-balances. The desks installed last summer differ by the addition of a cupel-drawer and the omission of the balance-locker. This arrangement reduces the number of balances required by one-half, and also gives the student a tray for cupels which otherwise would have to be kept in his locker below. The desks are placed in six sections; the three new sections contain eight desks each, and the three original ones contain six desks each, with three deep slate sinks at the ends. The desks have individual electric lights, are supplied with gas, and are subdivided to accommodate 84 students in two divisions. Distilled water is supplied from bottles supported on the top shelves. To prevent the stoppage of the sink-drains by ores from the preliminary vanning, and to prevent the destruction of the waste-pipes from acids, a 2-in. overflow is placed in each discharge pipe, and the bottom of the sink is covered

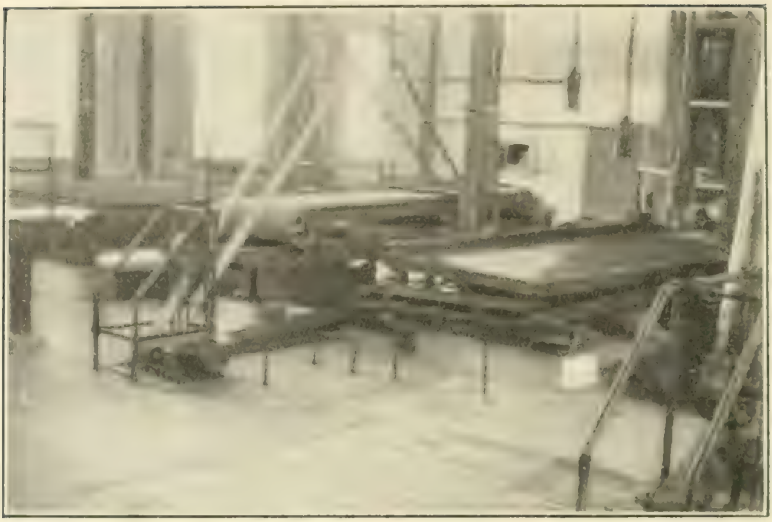


FIG. 7.—CONCENTRATING-TABLES.

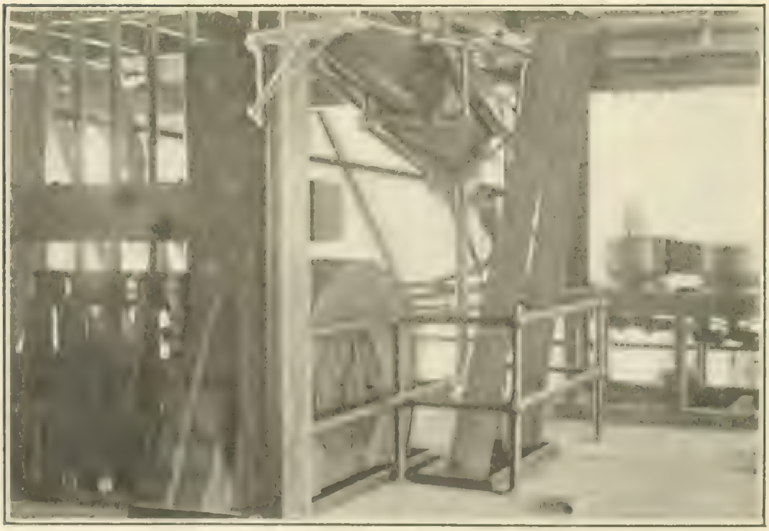


FIG. 8.—STAMP-MILL, TROMMELS, AND CLASSIFIERS.

with broken limestone. The balance of the equipment in the desk-room consists of a hood, pulp-balances with individual sets of weights, and the general supplies required by an assayer. The students are charged, at cost, with a complete outfit for assaying, including weights, crucibles, etc., and at the end of the term the supplies not used and in good condition are returned and full credit is given. The laboratory fee, which covers reagents and coal, is $15 for the course.

The second laboratory, adjacent to the first on the west, known as the furnace-room, has an available floor-area of 2,300 sq. ft., with a passageway of 10 ft. in the middle. As originally planned, this room was to have been devoted to assaying and metallurgy, but it has been found that the entire space will have to be devoted to assaying. The furnaces for metallurgical work, when built, will be installed on the proposed mezzanine floor, which will likewise have an area of 2,300 sq. ft. The two west windows in this room are door-windows, through which the soft coal is delivered to the steel coal-bin for the assay-furnaces. The bin is 3 ft. wide by 5 ft. high and 30 ft. long. Eight soft-coal, double-muffle assay-furnaces are installed 5 ft. in front of the coal-bin. Built of brick and lined with standard linings purchased from the Denver Fire Clay Co., these furnaces are similar to those used in the large mining and metallurgical works in the West. Each furnace has its equipment of tools for firing and muffle-work. The students fire their own furnaces, and are responsible for the furnaces assigned to them. Facing the soft-coal furnaces are five muffle-furnaces, built by the American Gas Furnace Co., and two crucible coke-furnaces. The gas-furnaces were purchased through, and erected free of charge by, the New Haven Gas Co. The crucible-furnaces were designed and built in the laboratory. Air is supplied to the gas-furnaces by a Roots rotary blower operated by a variable-speed motor. The blower is of sufficient size to furnish air to 12 gas assay-furnaces or a small cupola-furnace. The balance of the equipment consists of tables, pouring-molds, anvils, and the tools necessary for furnace-work. The floor-area in this room can accommodate 27 soft-coal, 8 gas-, and 2 crucible-furnaces. If gas-, gasoline-, oil- or crucible-furnaces are used in preference to the soft-coal furnaces, a much larger number can be installed. Soft-coal furnaces are preferable for students, being the standard furnaces used at large mines and

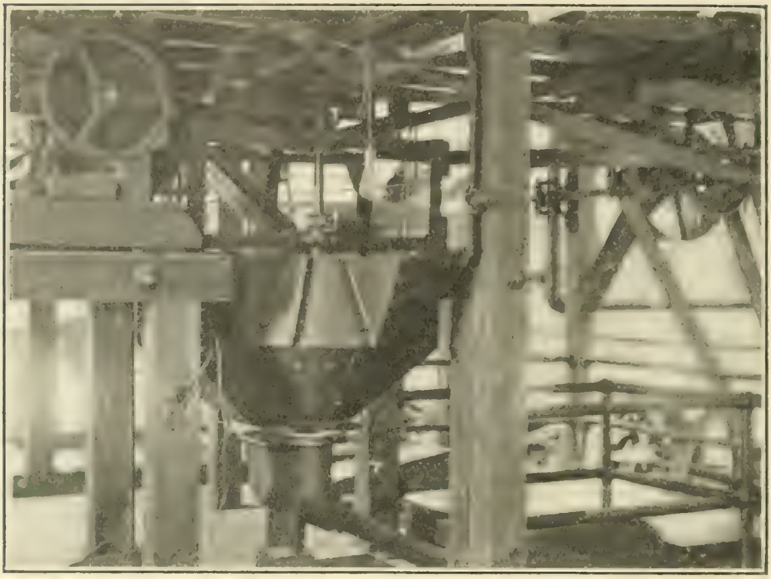


FIG. 9.—VEZIN SAMPLER, PRECEDING TROMMELS.

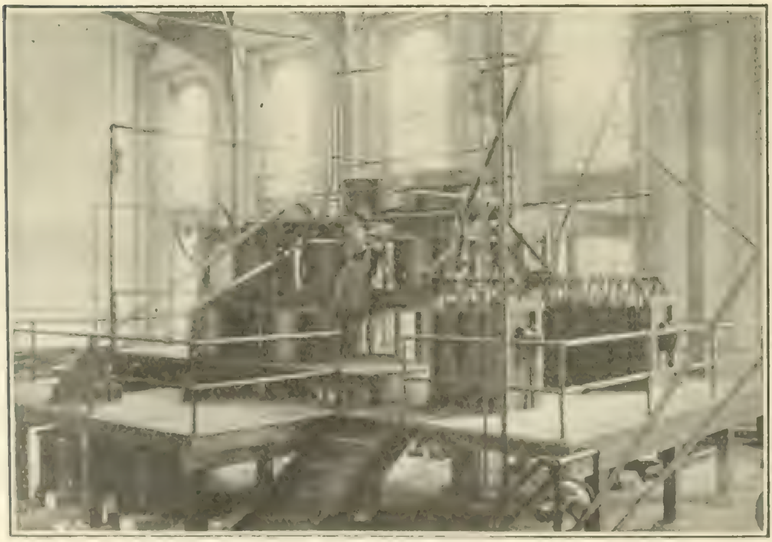


FIG. 10.—CYANIDING-PLANT.

metallurgical works. When the equipment is increased, a few gasoline-furnaces will probably be added in order that the students may become familiar with the operation of this type of furnace.

MILLING-LABORATORY.

The large room in the rear of the building, adjacent to the furnace-room, contains the concentrating-machinery. It has a central sump with the entire floor sloping to it. The concentrating-machinery is situated between the sump and the west wall. The cyanide-plant and five small amalgamating-pans are adjacent to the south wall. The remaining floor-area is reserved for new machines, dry-concentrators, and magnetic separators. To secure the desired fall for the ore, it was necessary to erect three floors adjacent to the west wall. These floors will not interfere with the mezzanine floors to be built later on both sides of the room. The concentrating machines were placed on separate concrete foundations extending 2 ft. below the ground floor and from 6 to 12 in. above the floor, depending on the machine. The stamp-mill foundation is a block of concrete, 8 by 14 ft. and 6 ft. deep, with a mortar-block of concrete, 5.5 ft. high. The machines are so arranged as to make their sequence interchangeable. The concentrating-machines on the main floor can be connected with centrifugal pumps, allowing the products to be sent to any other machine or to de-watering-cones placed on the top floor, the products of which, in turn, can be fed to classifiers or to any part of the room. The machinery can be operated for the testing of ores in car-load lots, or a small amount of ore can be circulated over one machine, allowing the student to study its adjustments.

The arrangement of the machinery installed is as follows: In the center of the room adjacent to the west wall is a platform-elevator for elevating ores to the various floors and the crushing-room. The five-stamp battery, with stamps each of 500 lb. and amalgamating-plates, is placed directly in front of the elevator. The battery can be fed either by a Challenge feeder or by hand. The pulp from the plates discharges to an amalgam-trap, and can then be fed to a centrifugal pump discharging to any machine or to de-watering-pans, the water being returned to the sump. To the left of the stamp-mill are the concentrating-tables, con-

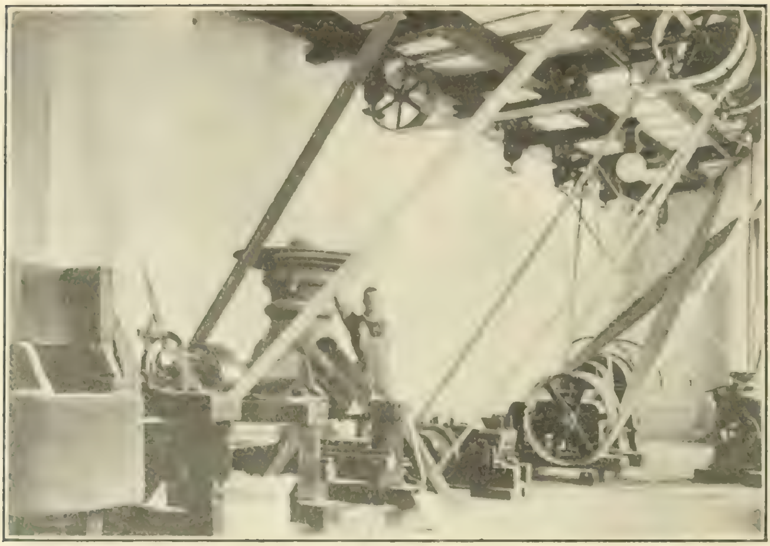


FIG. 11.—CRUSHING-ROOM.

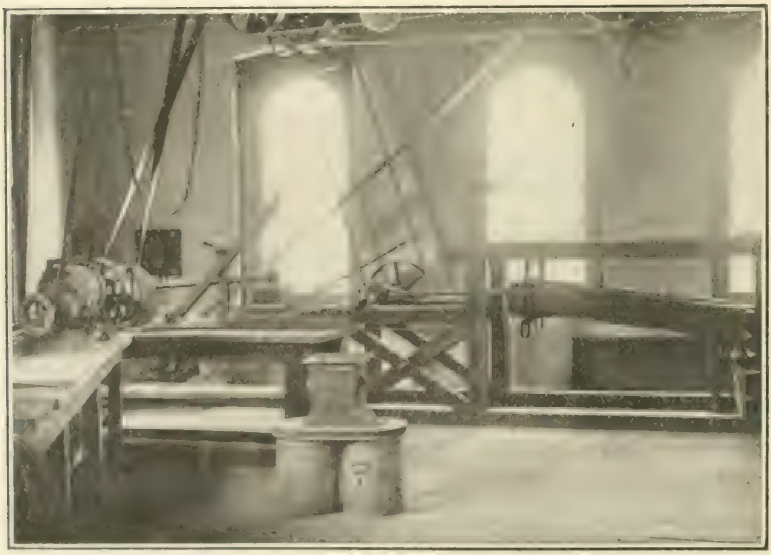


FIG. 12.—CRUSHING-ROOM, NORTHWEST CORNER.

sisting of a Wilfley table and a slimer, both donated by the Mine & Smelter Co., and a Frue vanner. The products from the tables can be fed to one of two centrifugal pumps placed adjacent to the tables or to de-watering-pans. To the right of the stamp-mill are placed a Huntington mill, jigs, an amalgamating-pan, and a clean-up pan. The Huntington mill is 3.5 ft. in diameter, with an apron plate for amalgamation. The pulp from the Huntington mill can be fed to a fourth centrifugal pump or to de-watering-pans. The jigs, of the Harz type, one of three and one of five compartments, 18 by 24 in., were designed and constructed in the building. They are elevated above the floor-level, allowing the products to be drawn off into de-watering-pans or to go directly to a centrifugal pump. The amalgamating-pan and clean-up pan are placed directly back of the jigs.

The first floor, at an elevation of 12 ft. above the ground floor, contains three Brown hydrometric classifiers. This floor is also the feeding-floor to the Challenge feeder preceding the stamp-mill. The second floor, at an elevation of 20 ft., contains three de-watering-cones. Between the second and third floors are a Challenge feeder, a Vezin sampler and three sets of trommels. The water-tank supplying the mill is on the top floor, and receives its supply of water from either the sump or the city supply.

The cyanide-plant consists of two solution-tanks, three ore-tanks, two 3-compartment precipitating-boxes, two sump-tanks, and a centrifugal pump connecting the sump-tanks with the solution-tanks. One of the ore-tanks is equipped with mechanical stirrers, and a second tank can be connected with a centrifugal pump for agitation. A Johnson filter-press, donated to the laboratory by the manufacturers, John Johnson Co., is adjacent to the cyanide-plant. On the platform containing the precipitating-boxes are two Harz jigs, 9 by 9 in., one of three and one of five compartments. Adjacent to the cyanide-plant are five small amalgamating-pans for the testing of ores. The balance of the equipment consists of motors, four large steam driers, one gas drier, and ore-bins. Six centrifugal pumps are used: four for elevating ores, one with the cyanide-plant, and one to supply the water-tank. Water- and gas-pipes, fitted with plugs every few feet, extend along both outside walls. In three corners of the room are electric switches for power. The concentrating-machinery is driven from a main line of shafting belted to a 35-h.p. motor. The cyanide-plant and amalgamating-pans are operated in like manner by a 5-h.p. motor. The ore-bins are adjacent to the west wall of the concentrating-machinery. It is intended to store car-loads of ore on the narrow strip of land south of the building.

CRUSHING-ROOM, BOILER-ROOM, ETC.

The crushing-room has a floor-area of 950 sq. ft., which may be extended on the north, giving a total area of 1,500 sq. ft. The heavy machinery along the interior wall consists of a Blake breaker, 10 by 7 in., tight-and-loose pulleys, driven from main line of shafting; a Gates gyratory breaker, size No. 0, style D, friction-clutch on breaker, driven from main line of shafting; a Dodge breaker, 4 by 6 in., tight-and-loose pulleys, driven from main line of shafting; crushing-rolls, 12 by 12 in., belt-driven from short shaft connected to main line of shafting by friction-clutch; an Abbé pebble-mill, 30 by 19 in., tight-and-loose pulleys, driven from countershaft; a Krupp ball-mill, tight-and-loose pulleys, driven from countershaft. The two machines last mentioned were gifts of the Abbé Engineering Co. and Thos. Prosser & Sons. The machinery along the exterior walls consists of a sample-grinder, coffee-mill pattern, tight-and-loose pulleys, driven from countershaft; a Case laboratory-breaker, a jar-mill, and a power bucking-board, all driven from second countershaft; a shaking-screen, with an adjustable stroke, speed, and inclination, driven from a double-cone friction-pulley. The remainder of the equipment consists of various samplers, screens, bucking-boards, and supplies necessary for the breaking, crushing, and sampling of ores. The main line of shafting is driven by a 15-h.p. motor.

Below the crushing-room the floor-space is subdivided into a repair-shop, boiler-room, and coal-bin. The repair-shop, triangular in shape, contains the general switch-board supplying the building with electricity. An electric switch provides the current for operating a 5-h.p. motor in the northeast corner. The room is lighted by three windows and ceiling-clusters. It is intended to install in this room a lathe, drill-press, and other machines for repairs and construction as required.

The boiler-room contains two boilers for heating the building with steam. This room is lighted by three windows and electric lights. In the ceiling is an opening to permit the radiated heat from the boilers to enter the crushing-room.

In the northwest corner is the coal-storage, with windows on the railroad-siding and yard. It is of sufficient size to hold a car-load.

FLOOR-AREAS.

The total floor-area in the building amounts to 22,871 sq. ft.; the front portion contains 6,691 sq. ft. and the laboratory portion 16,180 sq. ft. By the building of the mezzanine floors, planned in the original design of the building, this floor-area can be increased by 10,750 sq. ft., making a total available area of 33,621 sq. ft.

The subdivisions of the area are as follows:

FRONT PORTION.

Basement.	Sq. Ft.
Research-room, H	336
Research-room, H_1	336
Instructors	216
Balance-room	264
Stock-room	168
Sample-room	55
Dark-room	77
Locker-room	288
Lavatory-room, M	283
Lavatory-room, M_1	120
Showers	40
Total	2,183

First Floor.	Sq. Ft.
Library	420
Museum	1,188
Office	396
Closets	100
Total	2,104
Second Floor.	
Lecture-room	1,554
Lecture-room	506
Instructor's-room	264
Closet	80
Total	2,404

LABORATORIES.

	Sq. Ft.	Sq. Ft.
Ore-testing		1,320
Assaying:		
Desks	1,320	
Furnaces	2,640	
Balances	264	
		4,224
Milling, ground floor	6,400	
Floors	2,600	
		9,000
Crushing-room		950
Total		15,494
Repair-shop, Furnace-room, etc.		950

AVAILABLE BY BUILDING MEZZANINE FLOORS.

	Sq. Ft.	Sq. Ft.
Metallurgy:		
Furnaces	2,300	
Desks	1,150	
		3,450
Instructors		1,150
Milling-room		5,600
Crushing-room		550
		10,750

DISCUSSION—THE HAMMOND MINING AND METALLURGICAL LABORATORY OF THE SHEFFIELD SCIENTIFIC SCHOOL.

PROF. HUNTOON: You will notice in my paper that it includes a number of photographs which have been taken showing the assay desks, the furnace room, the ore-testing laboratory, concentrating tables, cyanide plant, etc. As soon as we have seen the lantern slides, I am going to ask you to accompany me, and I will take pleasure in showing you the equipment of the building.

Now we will have the slides, and I will give you, an idea of the various portions of the plant from the pictures and how the machines are used in concentrating ores.

Now are there any questions?

MR. WASHBURN: How do you get those ores?

PROF. HUNTOON: They come to us from all parts of the country. When a sample reaches the School an assay is first made, and then it is tested to determine the most economical method of extracting the values.

MR. WASHBURN: I mean where it comes from first. Are those specimens picked out as being especially adapted?

PROF. HUNTOON: Oh, no; they are not merely typical specimens of ore. Lots of a few pounds to a carload are sent to us from all parts of the country. They include all kinds of ores, gold, silver, copper, lead, etc. After they have been tested they are turned over to the boys who work at them for the purpose of getting a practical idea of assay work and ore testing. Nearly all of the points which I have covered in what I have said to you are included in the paper, and perhaps stated there more clearly than I have brought them out in what I have said to you. I have some copies of the paper, and will be glad to distribute them to any who would care to have them.

Of course, one purpose that we have in mind, in placing these ores in the hands of the students, is to let them see the difficulties they are liable to run up against in practice. The students know nothing about the contents of the ores given to them for assay. They first wash the ores and then make a quantitative test by fire and report the result on a printed certificate. They must have correct results in dollars and cents, otherwise they are given no credit for their work. The aim is to make the instruction as practical as possible.

Now if there are no further questions in regard to the ores, we will go downstairs and inspect the plant.

STATE CONTROL OF CONNECTICUT DAMS.

By C. E. Chandler, Mem. Conn. Soc. C. E.

Before 1800 practically all the dams in Connecticut were on very small streams and the most of the power was used to run grist and saw mills. The former were generally run a small number of hours daily, while the latter were often used only during the wettest spring months.

The circumstances preceding the War of 1812 caused the beginnings of textile manufacturing in New England. The coincidence of the invention of textile machinery gave a great impetus to the development of water power in Eastern Connecticut. A large number of dams were built, but they were for the most part on streams of moderate size. With few exceptions this remained the case up to the Civil War.

The most important exception was at Norwich, Conn., where about 2000 horse power was developed by a water power company in 1830.

The high prices and large profits incident to the Civil War caused the development of water power on a much larger scale. Large and expensive dams were built at Baltic, Occum and Taftville in Eastern Connecticut, and at Derby and elsewhere in other parts of the State. Previous to 1860 very few dams existed, the failure of which would cause serious damage to life and property. Soon after the end of the war reservoirs began to be built in connection with water supplies.

In 1876 there was a great freshet in Connecticut. Large numbers of dams for water power and water supplies had been built since any great freshet had occurred. This was their first trial and many were found wanting. A large number of dams failed.

As a result of these failures, and to prevent other such failures from occurring, the Connecticut Legislature passed, in 1876, a law which provided, among other things, that the engineer member of the Board of Railroad Commissioners and an engineer in each Congressional district should constitute a board of civil engineers; that all dams the failure of which might endanger life and property should be planned and built under their supervision, and that such old dams as interested parties and the selectmen shall consider unsafe, shall be examined by a member of the board, and repaired under his supervision if he considers them unsafe.

Mr. William O. Seymour was then, as now, the civil engineer member of the Board of Railroad Commissioners. He appointed C. L. Burdett of Hartford, B. H. Hull of Bridgeport, N. J. Welton of Waterbury, and Henry T. Potter of Norwich as the remaining members of the Board of Civil Engineers having supervision of reservoirs and dams.

When a new dam is to be built or an old one to be repaired in consequence of having been found unsafe, both by the selectmen of the town and a member of the Board of Civil Engineers, the law requires that the work be done under the supervision of a member, but the member has no further responsibility. The owner may increase the pressure on the dam, and decrease the capacity of the spillway immediately after the dam is approved, so far as the duty of the engineer is concerned.

The only report of the doings of the members required by law is a certificate of approval to be recorded by the owner in the Land Records of the town. It is not required that such certificates shall furnish any information as to the dimensions of any part of the dam, the character of the foundation or the kind or quality of the material.

If at a later time the owner wishes to enlarge a dam that has been approved, or if by any means such a dam becomes unsafe in the opinion of parties who would be damaged by its failure, no useful information regarding the character of the dam is available by reason of compliance with the law in the original construction.

On this account it seems as though this Association could perform a useful service to the people of the State by obtaining all the information it can regarding the dams that have been approved by the State Board. Such information would be of use also to all members of the Association whose experience in the construction of dams is limited, and who may in the future have occasion to design dams.

The electric transmission of power, and the constantly increasing need of water by cities and towns, has recently caused the erection of many dams and will cause the erection of many others in the near future.

Two questions frequently arise regarding State approval of dams:

1. Is State approval necessary when a change in the height of a dam is to be made, or other material is to be substituted for that already in an existing dam?

2. Should State approval be sought where the probability of damage to life or property is small, in case of failure of the proposed dam?

A strict and literal construction of the law does not seem to cover the first case, while a liberal and sensible interpretation does. In the second case only the Court has authority to draw the line. In either case, however, the owner of the dam has a much better standing when he has the work approved by a member of the Board.

The increasing importance of the matter is shown by the fact that as many dams received State approval the past two years in the third Congressional district as during the first fifteen years after 1878, when the law was passed.

MEMORANDUM OF WORK ON CONNECTICUT DAMS

By N. J. Welton, C.E., of Waterbury, a Member of the State Board of Engineers.

An Act to provide for the supervision of reservoirs and dams was passed by the General Assembly of the State of Connecticut.

Approved March 28, 1878.

Section first provides that the member of the Board of Railroad Commissioners who is a civil engineer, and one civil engineer residing in each Congressional district in the State, to be appointed by him, shall constitute a Board of Civil Engineers, and have the supervision of all dams and reservoirs now existing or hereafter constructed in any locality whereby the breaking away of the same life or property may be in danger of destruction. The first Board was as follows:—William O. Seymour of Ridgefield (ex officio); N. J. Welton of Waterbury; T. H. McKenzie of Southington; H. T. Potter of Norwich; B. H. Hull of Bridgeport.

STATEMENT OF WORK DONE BY THE UNDERSIGNED, A MEMBER OF SAID BOARD, UNDER SAID ACT.

In April, 1879, at the request of the selectmen of the town of Wolcott, I inspected the Chestnut Hill reservoir and dam situated in said town, owned by the Mad River Company.

The dam was found unsafe. Rebuilt and accepted. As rebuilt it is composed of puddled earth, protected by heavy rubble masonry on both slopes. It is 600 feet long and 15 feet wide on top and 35 feet high.

The reservoir when full contains about 250 million gallons.

In 1883-4, two dams were built by the Southington Water Company, T. H. McKenzie, engineer, across Humiston Brook, one in the town of Wolcott and one in the town of Southington; one a large earth dam for a storage reservoir, and one a small masonry dam for a distributing reservoir. Accepted October 1, 1884.

GENERAL VIEW OF MAGONEY DAM AT WIGWAM RESERVOIR.
Built by the City of Waterbury.

In 1884, one dam for the Sperry Manufacturing Company, across Beaver Brook in Ansonia. A masonry dam with center overflow. The inner slope well graveled and puddled. Cost about $8,500. Plans by Welton & Bonnett, C.E. Accepted October 1. 1884.

One dam for the Ansonia Water Company, across Beaver Brook in Ansonia.

This dam, built in place of one washed away in the winter of 1883-4, is of masonry with earth embankment. The bottom is on a timber, plank and concrete foundation seven feet below the old foundation. Depth of water in the reservoir, 14 feet. Accepted April 14, 1885.

One dam for B. Dickerman in Westville, town of New Haven. An earth dam with puddled clay section in center, 1100 feet long, with masonry overflow. Slopes rip-rap; 8 feet of water. Accepted May 5, 1885.

One dam for the Bristol Water Company across Green Briar Brook in the town of Bristol. This dam is built of earth with masonry wall in center, 9 feet thick at bottom, 2½ at top and 22 feet high. Length of dam, 250 feet. The center well laid in cement, banked with earth both sides and puddled, usual slopes. Top 20 feet wide, with wasteway at north end and wasteway pipes through the dam. This dam was all day work, under the direction of J. M. Colley of Waterbury; 1100 barrels of cement was used. Accepted May 30, 1885.

One dam built by the Plainville Water Company, in the town of Southington. Work by C. W. Blakeslee & Sons of New Haven. Accepted June 15, 1885.

One dam built by I. Goffe Phipps at West Haven, town of Orange. Accepted Sept. 4, 1885.

One dam built by the Board of Water Commissioners of the Borough of Danbury at East Lake so-called.

The foundation for this dam was constructed under and by authority of a certificate issued October 30, 1885, by William B. Ryder, a member of the State Board of Engineers, and in accordance with plans and specifications approved by him as appears of record.

The remaining portion of the dam was constructed under authority of the undersigned. It was accepted conditionally

December 3, 1886. A final inspection and acceptance was made October 6, 1888.

One dam in the town of Seymour built by the Ansonia Water Company, J. M. Wheeler, engineer, across Beaver Brook. This is a masonry dam 218 feet long, 20 feet high above bed of brook to overflow. Wall 16 feet thick at bottom and 4 feet on top with a puddle embankment of gravel, sand and clay, with slope of 2 to 1 on the upstream side. Also an additional dam across a ravine about 160 feet long and 16 feet high. Accepted May 23, 1887.

One dam built by the Fountain Water Company, at West Ansonia.

This was an enlargement of present dam by an earth embankment, raising the water line six feet. Accepted October 12, 1888.

One dam rebuilt by the Greenwich Water Company, at Putnam Lake Reservoir in the town of Greenwich, from plans and specifications prepared by William S. Bacot, C.E. Accepted February 15, 1889.

One dam built by the New Haven Water Company across West River in the town of Woodbridge, in accordance with plans and specifications by Lucian A. Taylor, C.E. Accepted November 20, 1890.

At the request of the First Selectman and Town Agent of the town of Lebanon, I inspected a dam belonging to the Bozrahville Company situated in said town.

I found that the dam was built of rubble masonry in 1888, with a section of concrete through the center and gravel bank on the inner slope, 200 ft. more or less in length and about 30 feet high at the bed of the stream. There were leaks in the dam which showed evidence of defective work. Made report of non-acceptance, September 2, 1889.

One dam rebuilt by William Garlick, called Beaver Pond dam, situate in the northerly part of the town of Meriden. A small earth dam with puddled earth and clay in the center. Accepted July, 1890.

Two dams built and rebuilt by the Birmingham Water Company at their upper reservoir on Derby Hill in the town of Derby, on plans by D. S. Brinsmade, C.E. Accepted December 12, 1889.

One dam built by the New Haven Water Company, across Sargent River in the town of Bethany. Accepted February 25, 1890.

One dam built by the New Haven Water Company, across West River in the town of Bethany, on plans by H. B. Gorham, C.E. Accepted December 15, 1894.

Two dams built by the Greenwich Water Company, across East Brook in the town of Greenwich, on plans prepared by William B. Bacot, C.E. Accepted May 30, 1894.

February, 1891, at the request of the Selectmen of the town of Plymouth, inspected a dam built by Christian Michaels, in the town of Plymouth. Unsafe. Rebuilt and accepted October 19, 1894.

A masonry dam 12 feet high with gravel on inner slope.

In July, 1890, in company with W. O. Seymour, Chairman of the Board of Engineers, inspected the dam of the Prout Hollow Reservoir, located in Middletown. Certain alterations and repairs were recommended.

One dam built by the Ansonia Water Company at "Peat Swamp" so-called in the town of Seymour. Accepted January 29, 1896.

One dam rebuilt by the Birmingham Water Company, on Derby Hill in the town of Derby. The lower reservoir. Accepted December 21, 1896.

One dam rebuilt by the Oakville Pin Company, in the town of Watertown at Wattles Pond. Accepted October 9, 1893.

One dam built by the City of Meriden across the John Hall Brook in the town of Berlin. An earth dam with a core wall in center. Accepted September 10, 1897.

One dam rebuilt by the Waterbury Manufacturing Company, across Great Brook in the city of Waterbury. Approved October 4, 1897.

One dam rebuilt by the William Wilcox Manufacturing Company, across the Pameacha stream at Zoar in Middletown. Accepted November 1, 1897.

One dam built by the City of Middletown across Crystal Brook near Higby Mountain in said Middletown. Approved November 25, 1897.

One dam built by the Seymour Water Company, across "Toby Brook" in the town of Beacon Falls. Accepted December 1, 1898.

Two masonry dams built by the Branford Lighting and Water Company, at Branford. One for a storage reservoir across Farm

Brook and one for a distributing reservoir on Maple Hill. Both accepted September 21, 1899.

One dam built by Thomas H. Hayes at Pearl Lake in Waterbury. Accepted June 16, 1900.

One masonry dam by the Great Brook Manufacturing Company, across Great Brook at the Great Brook Reservoir in Waterbury. R. A. Cairns, C.E. Accepted October 11, 1902.

One dam built by the Watertown Water Company, in the town of Bethlehem, across Thompson Brook. An earth dam with a concrete core wall in center, 20 feet high. Inner slope paved. Plans by Loring N. Farnum, C.E. Accepted November 8, 1899.

Two dams built by the City of Waterbury across the west branch of the Naugatuck River, in the towns of Watertown and Thomaston. The location for one, the masonry dam, was approved September 6, 1893. The other, the earth dam, site approved May 30, 1895. Dams accepted November 20, 1895.

A plan to raise both dams 15 feet was approved January 15, 1901. The earth dam was accepted November 30, 1901, and the masonry dam July 2, 1902. The plans for the dams and the building of the same were by Robert A. Cairns, C.E., City Engineer.

Extract from the City Engineer's report for 1902:

"The general appearance of the masonry dam after its completion is well shown in the accompanying cut (see p. 66). At the present time this is the highest masonry dam in New England. It is 91 feet high from the lowest point of the foundation to the top of the coping, and about 600 feet long on top. The water at the dam is 70 feet deep.

"The reservoir is about one and one half miles in length, has a surface area of 105 acres, and a total storage capacity of 730 million of gallons. The tributary water shed has an extent of 18 square miles."

The reservoir has two overflow weirs; one at the earth dam is 170 feet in length and one at the masonry dam 48 feet long, the latter divided into three parts by the piers of the arches which carry the top of the dam. This makes the total spillway length 218 feet.

All of the above described dams built and rebuilt under authority of the undersigned are, in my judgment, strong, safe and secure.

In July, 1903, the undersigned resigned the position after twenty-five years of service, and Mr. William G. Smith, C.E., of Waterbury was appointed to fill the vacancy in said board.

Waterbury, January 27, 1910.

Nelson J. Welton, C.E.

The present Board is as follows:—William O. Seymour, of Ridgefield (ex officio); T. H. McKenzie, of Southington; William G. Smith, of Waterbury; H. G. Scofield, of Bridgeport; Charles E. Chandler, of Norwich.

DAMS APPROVED BY MR. HENRY T. POTTER.

By Charles E. Chandler, Mem. Conn. Soc. C. E.

Mr. Henry T. Potter of Norwich, Connecticut, was the first member of the State Board of Engineers from the Third Congressional district. The appointment was an especially judicious one, as Mr. Potter's experience with important dams exceeded that of all other engineers in the district, and perhaps exceeded that of any other engineer in the State.

He declined to call himself an engineer, saying that he was a builder of engineering works. He was, however, a designer of engineering work and designed all of his own work so far as I know. He is said to have been foreman of a machine shop when he was eighteen years old, and from building machinery he came to building mills and dams.

Between 1860 and 1870, Mr. Potter designed and superintended the construction of three dams on the Shetucket River, two of them about twenty-five feet high and one of them about fifteen feet high, and the Ousatonic dam on the Ousatonic River about twenty-four feet high. These dams are still among the very largest in the State; the drainage area at the first three dams being 459, 477 and 526 square miles respectively, and at the latter dam 1560 square miles. All these dams were built on a rather poor gravel foundation.

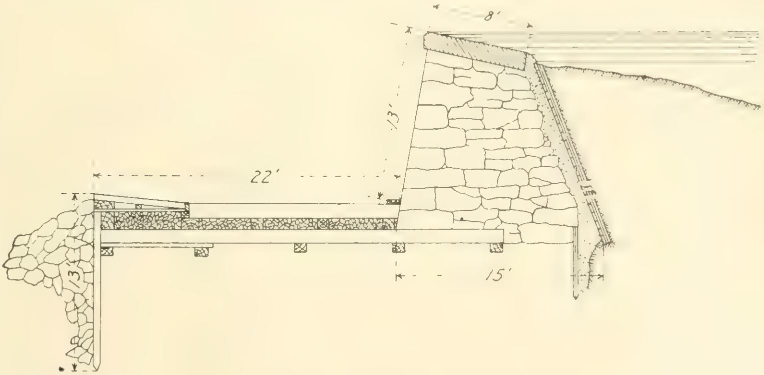
Stream flow data in this country were scarce in the 60's, and only the smaller streams had, as a rule, been developed.

Accidents occurred in the building of these larger dams that made Mr. Potter's experience more valuable than it would otherwise have been.

As the law does not require that members of the State Board of Engineers should report their designs to any one, there is no convenient way to find out how many or what dams have been brought to their attention officially. From such plans as Mr. Potter left among his papers, kindly loaned me by his family, from my own personal knowledge and from certificates on the Land Records of the various towns in the district, it appears that Mr. Potter had some official connection with nine dams.

The first dam was built in 1881 and 1882 on the Shetucket River in Norwich at a point where the drainage area is about 1,250 square miles. The rollway was four hundred feet long by twelve feet high. The height of abutments has since been increased four feet.

The material for the foundation was loose gravel more than sixty feet deep. The dam was built of rubble masonry laid in cement mortar coped with granite. The specifications did not call for full mortar joints, as the writer remembers them, but simply required that the stones be well bedded in mortar. There was a concrete facing on the upstream side of the dam, and earth filling as shown by the original plan. (Figure 1.)



Eng Contg.

FIG. 1.

This plan calls for the base of the dam to be one foot below the bed of the stream, and to be fifteen feet wide including one foot of concrete facing and fifteen feet high. The crest is of granite blocks seven and one-half feet wide across the dam, inclining upstream on a slope of five to one.

The apron is twenty-two feet wide and is a crib of three layers of twelve inch timbers at right angles to each other six feet apart; the lower layer cut into the bed of the stream and the others filled with stone and covered solid with twelve-inch timbers laid parallel with the stream. The seven feet of timbers farthest downstream had an upstream slope of six inches to keep standing water on the apron.

The form of the timber apron was changed in 1885 to that shown in figure 2. The new apron had no back slope.

About two hundred feet of this rollway went out in the great freshet of 1886, and it was replaced by a timber dam, built in accordance with figure 3.

The new work is an immense timber crib two hundred feet long, sixty-eight feet wide, and twenty-four feet high, entirely filled with stones and gravel. The whole crib was built in place, stick by stick, and it floated on the water in the excavation made by the washout until it grounded.

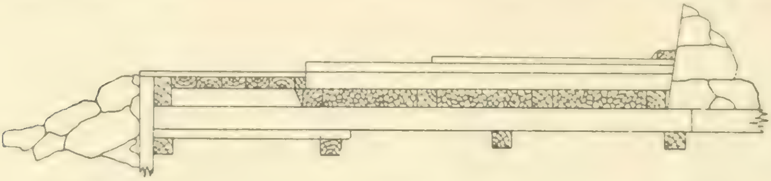


FIG. 2

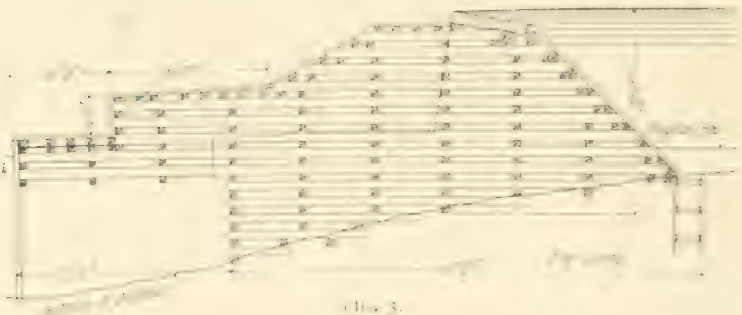


FIG. 3.

This timber crib was extended along the remaining two hundred feet of the dam so that the external appearance is uniform, and the relative position and magnitude of the new and old sections is shown in figure 4.

As about one-half of the dam went out and the balance remained undamaged, it is fair to assume either that the material under the part that failed was poorer than that under the balance, or that something happened to one part that did not happen to the other. As during the freshet large quantities of drift passed by, including whole trees, parts of bridges and buildings, the latter may be the case. It is claimed by some that an oil tank floated over the dam and broke the apron.

His second dam was on the Quinebaug River in the town of Thompson, where the drainage area is in the neighborhood of one hundred seventy-five square miles. No plans of it exist so far as the writer knows. My recollection of it is that there was no core wall, except a low one to break the joint between the natural ground and the embankment. A highway occupies the top of the embankment. There was considerable seepage at the foot of the slope and a drain was laid to carry the water into the river.

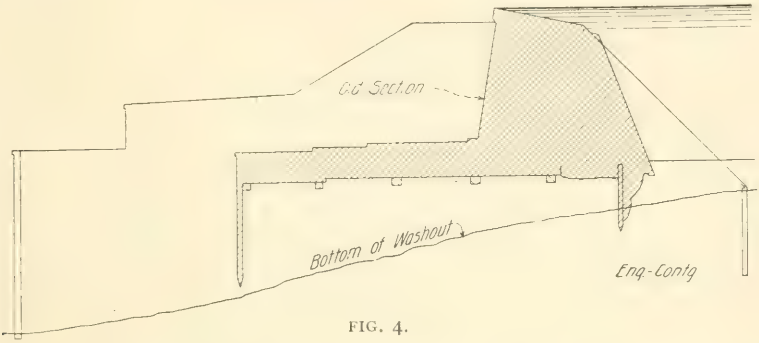


FIG. 4.

The following account of this dam is from Professor Dwight Porter's description of the water power on streams tributary to Long Island Sound:

> "At the site of the new dam the river-bed is gravel, with some quicksand. The dam was carried down 3 or 4 feet below the surface of the apron into the river-bed and protected by sheetpiling, in the usual manner. The rollway is 200 feet long, rises 15 feet above the apron, is 4 feet wide on top, 30 feet wide at the base, and has front and back slopes of 20 feet each. The back slope is covered with 2½-inch, the top with 4-inch, and the face with 3-inch chestnut planking. In interior construction the dam is a log crib-work filled with stone. An apron projects 16 feet beyond the foot of the dam, and has a permanent covering of 4-inch chestnut plank, over which is a temporary layer of 2-inch white oak plank, easily renewed when worn out. From the roll-way there extends a gravel embankment 900 feet long, about 20 feet high, 60 feet wide at the base and 24 feet at the top, the inner slope of which will be riprapped."

The embankment is six feet above the crest of the dam.

The third dam Mr. Potter was called to act on was in Woodstock, on a stream of about seven square miles drainage area.

It does not appear that State approval was asked on the original plans. The plan from which the dam appears to have been originally built is shown in figure 5.

The specifications read as follows:

> "The masonry to be good rubble work laid in a good workmanlike manner, to be 20 feet thick at the base for a height of 32 feet and in that proportion; top to be 40 inches thick. Batter on water side 5⅔ inches per foot. The lower side to be perpendicular for 12 feet; above that batter of 1½ inches per foot. On upper side of dam logs of 12 inches in diameter laid horizontally 5 feet apart and planked perpendicularly with good chestnut plank 2 inches thick. The whole to be graveled to within 2 feet of top and puddled for 3 feet in width from planking. Top of graveling to slope on an angle of 30°. For further details reference is made to a plan enclosed herewith."

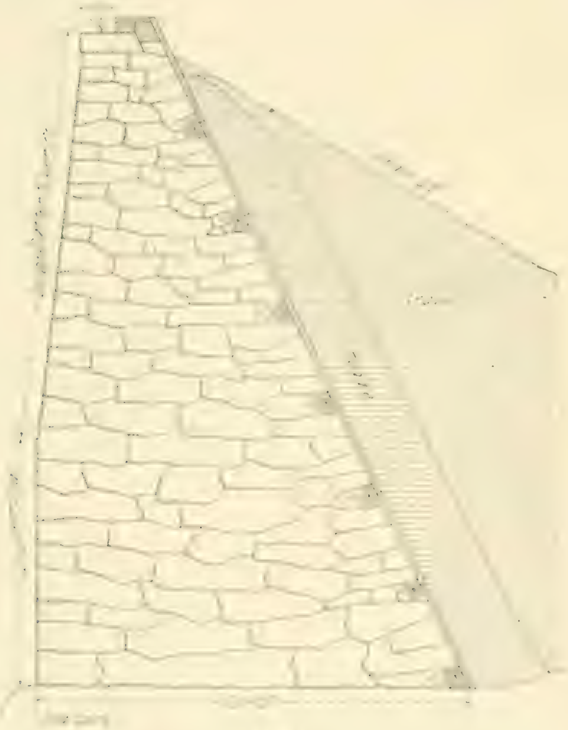


FIG. 5

The foundation appears to be ledge. The rubble was evidently intended to be dry, as no mortar is mentioned. The proposed length of wasteway is not given, neither is plan or specifications, but it now measures one hundred thirteen feet with abutments two and one-half feet high. Among Mr. Potter's papers is a pencil sketch made, probably, by Mr. Potter, which is shown in figure 6. They built the dam like the original drawing, and after it had bulged from A to B, they consulted Mr. Potter and braced it up by adding ten feet on downstream side at bottom, taking down the old part to C.

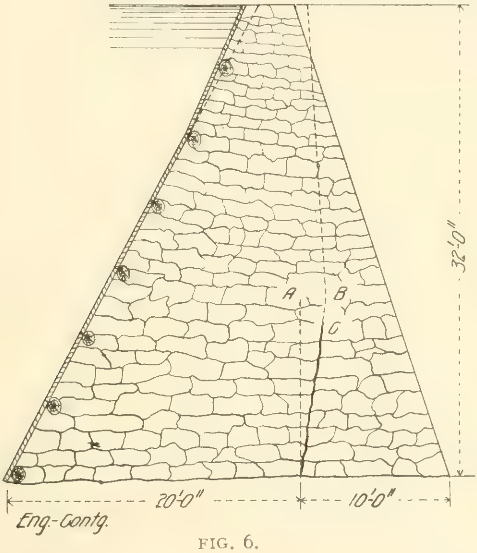


FIG. 6.

Mr. Potter's certificate reads as follows:

> "This is to certify that N. T. Adams of South Woodstock had made, under my direction and supervision, added to, and rebuilt his dam to such extent and manner necessary to make it safe and permanent and in my opinion sufficiently strong and substantial to withstand the action of water under any circumstances which may reasonably be expected to occur.
>
> H. T. POTTER.
> One of the Board of Civil Engineers for
> the Supervision of Reservoirs and Dams."

South Woodstock,
Oct. 11th, 1883.

The privilege has not been in use for many years. The mill owner below was afraid of the dam, and its owner dug a channel through it about thirty-seven feet wide at the top and twenty-five feet deep. The experience on this dam plainly teaches, however unnecessary the lesson appears to be, that a dry wall thirty-two feet high with a twenty-foot base, and a vertical downstream face for a third of the way up, is wholly inadequate.

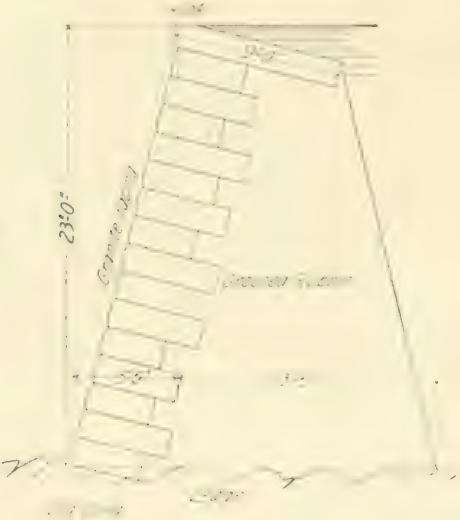


FIG. 7.

Dam number four was built on the Pachaug River in the town of Griswold, at a point where the drainage area is sixty-two square miles. The legal length of the rollway is eighty-two and one-half feet. The plans call for a rollway one hundred and ten feet by five feet. The eighty-two and one-half feet were placed at the legal height and the balance about one foot higher.

The foundation is ledge rock.

The cross section is shown in figure 7. For a height of 23 feet it calls for a base of nineteen feet and a nine-foot coping sloping two feet.

The specifications were as follows:

> "The masonry of the face of the dam to be of granite and shall have an average thickness of 3½ feet. It shall be cut and laid with joints not exceeding ¾ of an inch in thick-

ness for a distance of 12 inches back from the face. The courses shall be laid breaking joint and shall have headers not less than 2 feet 6 inches long on face and extend back into the body of the dam not less than 4½ feet. Headers to average not more than 10 feet apart in each or the same course and alternate in succeeding courses.

The back of the dam and abutments shall be of good rubble work thoroughly laid in cement mortar and properly bounded to interior. All spaces in the interior to be well filled with medium size and smaller stone and thoroughly grouted with cement grout, to make when complete a solid mass of masonry.

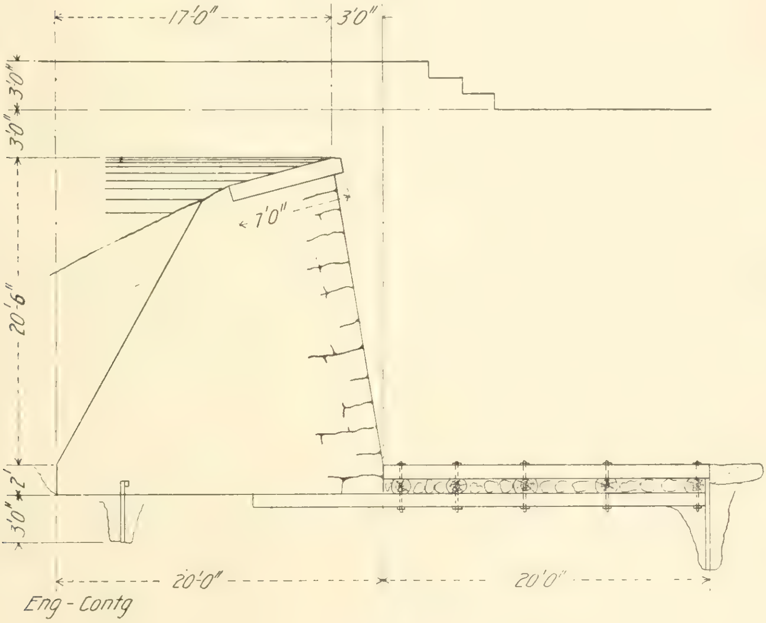


FIG. 8.

The stone piling walls as shown on the plans to be laid with suitable size stone, thoroughly laid in cement mortar and all spaces completely filled.

The coping will be of granite of thickness and length as shown on plans, cut on front edge and top bevel, and thoroughly bedded and secured to other stone work of the dam. The vertical and top joints not to exceed one-half inch in thickness.

> After the masonry is in place a filling of earth and stone is to be put in at back of dam as shown on plans."
>
> "The rock under dam and abutments to be excavated to such depth as to give a good footing for the base and toe of the dam. The bottom of the river will be stepped or channeled as shown by plans, as decided advisable by the superintendent in charge, in order to guard against leakage between the dam and rock, and all hollows and channels thoroughly filled with grouted work.
>
> The top surface of the filling of dam will be protected by riprap of stone suitably laid and extending back a distance of about six feet from back line of coping.
>
> All mortar to be composed of hydraulic cement of some approved manufacture and good clean sharp sand mixed in the proportion of two of sand to one of cement. The mortar to be prepared only as fast as wanted and none having once set to be mixed and used in any part of the work."

This is a first-class dam on a first-class foundation.

His fifth dam was on the Pachaug River, where the drainage area is sixty-one square miles. The spillway is one hundred and eleven feet long by seven feet high. The cross section of the spillway is shown in figure 8. The foundation is excellent blue gravel.

The specifications were as follows:

> 'The whole ground to be occupied by rollway, abutments, and apron is to be excavated to the depth of bottom of mudsill under old apron, which is to be known as the *grade line*.
>
> The priming or sheet piling under dam and abutments is to be set four (4) feet from upper face of dam in the middle of a trench excavated three (3) feet wide at a level three (3) feet below grade line or as much lower as may be necessary to get to good material.
>
> Except that if boulders too large to be readily removed without blasting are met, the piling may be scribed to them, and the joints well cemented.
>
> Piling to be sound chestnut plank three (3) inches thick, free from unsound knots and wormholes and accurately jointed, or of three (3) inch spruce plank tongued or carefully hand splined and grooved, and free from loose knots.
>
> The piling is to be pointed and cornered and driven as far below bottom of trench as is practicable with an eight or ten pound hammer in such a manner that it may and shall be watertight.

The top of piling is to be spiked to a 3 inch x 4 inch scantling.

The trench is to be backfilled with blue gravel and carefully puddled. The piling shall extend through the abutment and connect with a twelve (12) inch priming, beginning at a depth of bottom of plank and stepping up into embankment as shown on plans.

The top of brick priming to come within one (1) foot of top of abutments and is to be built into a groove one (1) foot deep in back of abutments.

The brick shall be hard and well burned and laid solid in good cement mortar.

The stone used in rollway and abutments are to be good sound durable ledge rock carefully laid in cement mortar or grouted. The first course of stone in rollway and abutments to be laid in cement mortar. The stone in both faces of rollway and abutments to be laid in mortar for a distance of 12 to 18 inches and the remainder grouted. All voids in the stone work to be entirely filled with mortar or grout. All stones to be laid with their largest surfaces horizontal and in such a manner as to have good, firm bearings and bond well.

Coping is to be good sound granite not less than seven (7) feet long, three (3) feet wide and one (1) foot thick with side joints not more than ⅜ inches thick.

The rollway masonry is to be 20 feet thick at base and eight (8) feet thick at top.

The abutments are to be 12 feet thick at base and four (4) feet at top.

All mortar or grout used shall be composed of not less than one part good fresh-burned hydraulic cement to two parts clean sharp sand.

The apron is to consist of 13 or 14 sticks of chestnut or oak timbers called mudsills 28 feet long and ten (10) inches thick, hewn on two sides their whole length. They shall be bedded in the ground parallel with the stream with their tops at grade line and level both ways. The backfilling must be carefully puddled under and around them. They shall extend eight (8) feet under the dam and all have their largest ends upstream. They shall have a face on both sides of at least ten (10) inches for at least 18 feet and at small end at least nine (9) inches on upper side and three (3) inches on under side.

The stones laid on them shall have good beds to give a good bearing on the timber and earth and there shall be no joints in the first course over the timber.

The cross-sills shall be of good sound oak or white chestnut ten (10) inches thick and shall be spaced substantially as shown on plans. They shall have a face of at least ten (10) inches on upper side and have a face or be spotted at each intersection a width of at least ten (10) inches on lower side. The cross timbers at lower edge of apron shall be hewn on three (3) sides.

The last two of the cross-sills beginning at lower edge of apron must be fastened to mudsills with 1⅜-inch bolts with threads and nuts at both ends; the remainder may be fastened with ⅞-inch iron tree nails 20 inches long.

The cross-sills are to extend at least one (1) foot into the abutments. Where necessary to splice them it shall be done by halving them together as shown on plans over the mudsills. These splices must be so arranged as to break joints.

The top timbers are to be of oak ten (10) inches thick laid to a close joint parallel with the stream. They may be of any width at widest end and not less than nine (9) inches at narrowest end.

The wane must in no case exceed one (1) inch; yellow pine 12 inches square may be substituted for the oak.

The upper timbers are to be fastened to the cross timbers at each intersection with ⅞-inch iron tree nails 20 inches long. Wherever tree nails are used the holes in upper timbers are to be bored small enough so that some force will be necessary to drive irons into them and the holes in cross timbers to be 1-16-inch smaller.

Tree nails are to be slightly pointed cold and the heads heated and sufficiently broomed to take a firm hold on the timber.

The piling at lower edge of apron shall be of three (3) inch unjointed chestnut or spruce set in same manner as that under rollway and fastened to cross sill with seven (7) inch spikes.

This piling must go four feet below under side of mudsill, except in case of large boulders as mentioned for piling under rollway.

This trench may be backfilled with concrete, grouted stone work or puddled blue gravel.

All backfilling not otherwise specified must be well puddled blue gravel.

Should the foundation at the grade line be anything softer than blue gravel, said softer material shall be removed and replaced with puddled blue gravel or masonry.

The whole of said work both as regards quality of material and mode of operation is to be performed in the most thorough substantial and workmanlike manner and shall be water-tight."

This is an excellent dam and is Mr. Potter's ideal dam on a good blue gravel foundation.

The sixth dam was on the Pachaug River at a point where the drainage area is fifty-one square miles. No plans of this dam are in existence so far as the writer knows.

The following certificate from the Land Records furnishes some information regarding it.

"To all it may concern:

> In compliance with an act to provide for the supervision of reservoirs and dams, I make the following for record of my doings in the matter of the Pachaug reservoir dam owned and maintained by the Ashland Cotton Company, situate in the town of Griswold:—
>
> On the 20th day of August, 1886, I received a communication from the Selectmen for the town of Griswold in which they stated that they had received an application or petition dated July 31st, 1886, in relation to the Pachaug reservoir dam owned and maintained by the Ashland Cotton Company situated in the town of Griswold; that said applicants were severally the owners of property in said town of Griswold and would suffer great loss and damage by the breaking away of the said Pachaug reservoir dam owned by the Ashland Cotton Company in said town of Griswold; that said applicants believed said reservoir dam to be insecure and insufficient; they were therefore requested to forthwith inspect the same.
>
> On this application or petition, they on the 17th day of August, 1886, examined the said Pachaug reservoir dam, and in their opinion said dam was insecure and insufficient; therefore on the 18th day of August, 1886, they notified me to inspect the dam with them.
>
> Acting on this notice, I on the 23d day of August, 1886, met the Selectmen and examined the dam with them. The structure was a frame timber dam built about 20 years previous; in making the examination I found some of the timbers in the structure so much decayed that in my opinion it was insufficient and insecure. On this finding the Selectmen notified the Ashland Cotton Company to place said dam in a safe and permanent condition, under the act to provide for the supervision of reservoirs and dams.
>
> August 31st, 1886, I received a communication from the treasurer of the Ashland Cotton Company to the effect that he had had notice from the Selectmen to put the dam in a safe and permanent condition, and that he awaited my instructions.
>
> Owing to the condition of the dam and the desirability of holding back the water stored in the reservoir, it was decided

> to build a stone dam below as close as practical to the old one and fill in with gravel between the two. Under date of September 2d, 1886, to the treasurer, the following instructions were given.
>
> 'The following will enable you to commence the work on dam at once. The upstream face of the dam 4 feet from end of old apron and parallel with it. Base 20 feet wide. Coping 88 feet long; height determined from depth of excavation. Masonry rubble, laid in cement mortar and grouted. Apron and priming same as Ashland.* Plans for gates and other details given when wanted.'
>
> This stone dam is about 18 feet high from the foundation. The rollway or overflow is 121 feet 6 inches long, an increase of 29 feet 6 inches; the abutments and embankments are from 6 to 6½ feet above the crest of the dam, formerly 4 feet, thereby largely increasing the capacity for discharging and holding back water; and in my opinion the dam is sufficiently strong and substantial to withstand the action of water under any circumstances which may reasonably be expected to occur, and issue certificate accordingly.
>
> Norwich, Nov. 25th, 1889.
>
> H. T. Potter,
>
> One of the Board of Civil Engineers for the Supervision of Reservoirs and Dams."

The dam was built under Mr. Potter's direction, probably as near as possible like No. 5.

Dam number seven was to be built on the Moosup River at a point where the drainage area is about eighty-six square miles. The cross section for dam, drawn under the direction of the owner, is shown in figure 9. The cross section suggested by the engineer employed by the owner is shown in figure 10.

Both plans call for a crib dam of logs filled with stone. In figure 9 the base is thirteen feet for a height of twelve feet at the toe and four feet at the upstream end, and in figure 10 the base is [illegible] feet for the same heights. They call for aprons sixteen feet wide of 12 inch timber fastened to logs trenched into the bed of the stream.

The writer does not know which plan was followed. The plans called for a rollway one hundred eighty feet long and four feet high.

Dam No. 8.

The specifications were as follows:

Foundation for Rollway and Abutments.

"The whole ground to be occupied by the rollway and abutments is to be cleared of all loose material and excavated to the level of lowest point in bed of stream, after removal of loose material.

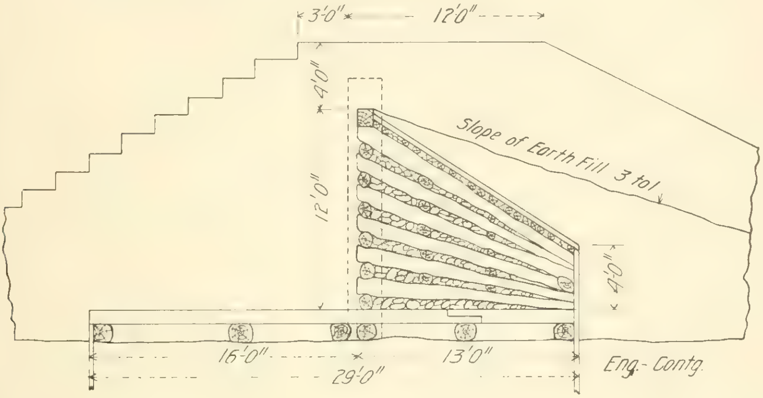


FIG. 9.

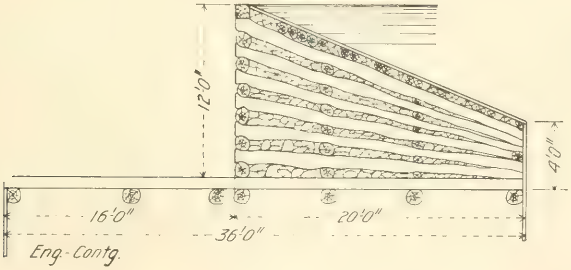


FIG. 10.

This level, provided the ground proves suitable, will be known as the *grade line,* and will be the level of the top of the mudsills.

Mudsills.

The mudsills are to be of good, sound chestnut or oak timber not less than ten (10) inches in diameter at small end, hewn on top so as to have a face of at least six (6) inches.

They must be properly spliced together, and the splices must break joints with splices in adjoining sills.

The mudsills at toe of dam will extend to connect with the priming under abutments and it will face on the upper side at least ten (10) inches.

The mudsills at lower edge of apron will be faced on the lower side at least six (6) inches.

All mudsills will extend about one foot into abutments except that at toe of dam.

The mudsills are to be firmly bedded in trenches excavated for the purpose with their tops at grade line.

Sheet Piling.

All sheet piling is to be of sound chestnut plank free from unsound knots and wormholes. Except at lower edge of apron it is to be accurately jointed or grooved and tongued or splined. The piling is to be pointed and cornered and driven as far below the bottom of trench as is practicable with an eight or ten pound hammer in such a manner that it may and shall be water-tight.

The trench is to be excavated three (3) feet wide at a level three (3) feet below grade or as much lower as may be necessary to find proper material.

The priming must be set in the center of the trench and the backfilling must be carefully puddled with best available material on both sides of the piling.

The piling at toe of dam will be spiked to upper mudsill as shown on plan and will be three (3) inches thick.

The piling at lower edge of apron will be two (2) inches thick and be spiked to lower mudsill.

The piling under abutment will be three (3) inches thick and be spiked to a 3-inch x 4-inch scantling which scantling will be spiked to upper mudsill.

Apron.

The apron is to be laid solid with good, sound chestnut or oak timber ten (10) inches thick.

At each bay of seven (7) feet the timber will extend back to mudsill under center of rollway and then be spliced to the corresponding timber of the rollway. The largest ends of these timbers to be laid upstream.

All other apron timbers are to extend one (1) foot under caplog. The apron timbers may be wider at one end than the other, but in no case less than six (6) inches wide. They must be laid with close joints and not have more than one (1) inch wane. They will be fastened to the mudsills at each intersection with 7/8 inch iron tree nails 18 inches long. The tree nails will be slightly pointed cold and the heads heated and sufficiently broomed to take a firm hold on the timber. The holes in apron timbers are to be bored 1-32 of a inch smaller than the tree nails, and the holes in mudsills ⅛ of an inch smaller than the tree nails.

Rollway.

The timber used in the rollway will be good, sound chestnut or oak of the dimensions shown on plans and hewn or spotted at all intersections and tree nailed as specified for apron at all intersections.

It will be planked on top and upstream side with good sound three (3) inch plank. All spaces between timbers are to be entirely filled with stone well packed to height five feet above top of apron and with stone or gravel above that height.

Timbers running across the stream must break joints, and those at upper and lower sides of dam must be continuous.

Masonry.

The abutments below face of retaining walls and above toe of dam, and the retaining walls, are to be good dry rubble on a good foundation. The abutments are to go at least one foot below the grade line.

The abutments above face of retaining wall and below toe of dam, and the priming, are to be good rubble thoroughly grouted in the following manner.

The bottom and both faces are to be laid in mortar composed of one part first-class hydraulic cement and two parts clean sharp sand, thoroughly mixed before wetting.

The interior is to be filled with a grout made by adding just sufficient quantity of water to the above described mortar to make it flow freely.

It shall be grouted in sections not more than ten (10) feet long and not more than 18 inches thick.

All of the grouted walls must be laid in trenches at least one foot below the *grade-line* or level at which the embankment begins.

In priming and abutments above face of retaining walls no stone is to go entirely through the wall.

Embankment.

The whole surface to be covered by embankment, including the space above the rollway, must be entirely clear of turf, brush, roots, and loose material of every kind.

The best available material must be used in the embankment, which must be carried up level in every part.

It must be put on in layers not exceeding six inches in thickness by dumping a single load of material in a place and leveling it off.

> The embankment is to be twelve feet wide at the top exclusive of the retaining wall and have a slope of two (2) horizontal to one (1) vertical.
>
> The loose material removed must not be used above the rollway nor in any part of the embankment proper.
>
> The whole of the work both as regards quality of material and mode of operation is to be performed in the most thorough, substantial and workmanlike manner."

Mr. Potter's eighth dam was for a storage reservoir on a stream with only three and one-half square miles of watershed, at a location distant from any village or railroad in the town of Lebanon.

The cross section is shown in figure 11.

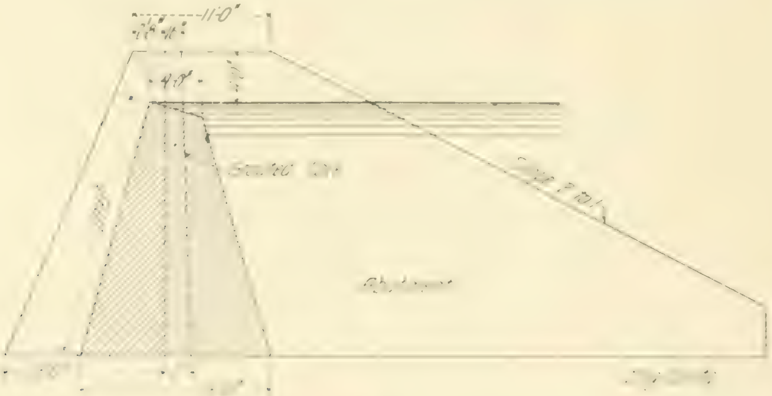


FIG. 11.

It calls for a dam consisting of a dry rubble retaining wall twenty-four feet high, thirteen feet wide and base forty inches at top; a mortared cut off wall or priming about twenty inches thick, and an earthern embankment on the water side seven feet wide at top with a slope of two to one.

The rollway to be of mortared rubble twenty feet high, fifteen feet thick at base and four feet at top. There are some discrepancies between plans and specifications, and the writer does not know which controlled.

The essential parts of the specifications were as follows:

> "The whole ground to be occupied by masonry and embankments is to be cleaned of brush, turf, roots and all loose material.

The ground to be occupied by the masonry is to be excavated to solid rock or to material suitable for a foundation. If the material on which the foundation for mortar work is begun should be a seamy rock, the seams must be thoroughly filled with cement mortar.

The priming wall will be 16 inches thick at top and have a batter of 3-16 inches per foot on each side, and its foundation will go at least three (3) feet below the bottom of embankment, unless the material is rock. The priming must be smoothly faced on both sides and plastered with cement mortar. No stones shall go entirely through the priming. The backfilling on both sides of priming wall is to be carefully puddled with the best available material.

The rollway will be four (4) feet thick at top and twelve (12) feet thick at bottom, and thirty (30) feet long at top."

"The rollway must start on a level or stepped foundation on lines parallel with the stream. The mortar work of rollway will extend at least one (1) foot into the face of abutments, where it will connect with the priming wall; that is, a part of the abutments of section equal to the section of rollway will be built as directed for rollway to a vertical line one (1) foot back of face of abutment at top and a section equal to that of the priming will be built in same manner to the same point, making a perfect water-tight connection between rollway and priming.

All masonry is to be good rubble work. All stones are to be laid on their largest surfaces and are to be of good sound stone with angular surfaces, and are to be wellbonded and so built as to make good strong work. No unbroken boulders are to be used.

The rollway and priming is to be built as follows: The bottom course and faces are to be laid in cement mortar composed of one part good hydraulic cement and two parts clean sharp sand, thoroughly mixed before wetting.

The interior of these walls is to be entirely filled with a grout made by adding sufficient water to the above mortar to make it run freely. The work shall be grouted in sections not more than two (2) feet thick in the rollway and eighteen (18) inches thick in the priming and not more than ten (10) feet long in either.

The abutments are to be four (4) feet thick at the top and the east one eleven (11) feet thick at the base, and the west one twelve (12) feet thick at the base."

"The top of priming is to be one (1) foot below top of embankment and top of rollway 3½ feet below top of embankment. The embankment will be 15 feet wide at the top with a slope of 1½ to 1 on the downstream side and 2 to 1 on the upstream side."

> "The coping of the rollway is to be of good stones not less than four (4) feet long across the wall and be laid with one-half inch side joints."
>
> "The embankment shall be built of the best available materials in level layers of not more than six (6) inches deep thoroughly rammed by carting over it to deposit the material and by thorough hand-ramming at points not driven over.
>
> The embankment must not be carried up on one side more than one (1) foot in advance of the other side.
>
> If the material is not carted with teams it must be kept carefully leveled and thoroughly and evenly wet.
>
> The whole of the work, both as regards manner of work and quality of material shall be performed in the most thorough, substantial and workmanlike manner and must be water-tight."
>
> "In case it should be decided to substitute a dry wall for the embankment on lower side of the dam the priming will occupy the same position and be of the same dimensions except that all of the batter will be on the upstream side and the priming will extend to the top of the embankment
>
> The top of the wall including priming will be four (4) feet thick and have a batter on the downstream side of five (5) inches per foot.
>
> The rollway will be of the same dimensions as the retaining wall including priming.
>
> The dry wall and the priming may be built together well-bonded or they may be built separately. If they are built separately the joint between them must be perfectly vertical, well-faced, and smoothly plastered.
>
> In this case there will be no wings below the face of retaining wall, but the pipe and buttresses will be put in the same as heretofore described.
>
> The retaining walls must be finished off with stones not less than four (4) feet long across the walls.
>
> The face of the dry masonry is to be well pointed."

The owner did not think an engineer or inspector necessary during construction.

The first time the reservoir filled the whole rollway went out, and the reservoir was emptied as promptly as any automatic flush tank. There was a rumor, that owing to a delay in arrival of cement several feet of the dam was built up dry and an attempt was made to grout it later.

The rollway was rebuilt according to the same plans and specifications under competent inspection and is still on duty.

His ninth dam was a water supply reservoir on a watershed of only one-quarter of a square mile, in the town of Norwich.

The specifications were as follows:

> "The entire surface to be occupied by the dam shall be well cleaned of top soil, etc. to hard pan or to a surface satisfactory to the engineer. It is thought that a depth of about four feet will be sufficient and it is so indicated on the plans, but it must go down to a satisfactory material whether more or less than the said four feet.

Trench for Core Wall in Hardpan:

> This trench is shown on the plans. It is to be about in the middle of the dam dug into the hardpan to a depth of three feet and about eight feet wide, the entire length of the dam. The width of about eight feet will be exactly determined by the engineer. The filling is to be thoroughly rolled for puddling, lengthwise throughout the entire length of the dam. Selected material is to be put into this trench in 6-inch layers and wet and rolled.
>
> After the core wall has been laid the whole surface of the puddling can be rolled close up to the wall and when the puddling has been brought above the top of the core wall there will be no barrier to the entire rolling of the puddle, which must be done in a uniform and thorough manner.

Core Wall:

> The location for the core wall is shown on the plans. It is to be three feet wide and about 360 feet long and a general average of eight feet high, except at the center of the dam at the deepest place, where it will be higher as shown by the plan. The trench for the core wall is to be three feet wide and one foot into the hardpan below the bottom of the puddle trench, making four feet into the hardpan. The core wall is to be laid well, using field boulders, etc. on the ground, but well placed to make a good solid well-bonded wall, laid in cement mortar of three parts of suitable sand to one of cement. The outside of the wall to bond in well with the puddling filling the trench solid.

Selected Material:

> The upstream side of the dam is to be selected material from the downstream edge of the level top, vertically down to the bottom, shown on the plan of the section by a heavy dotted line. All the material above this place is to be carefully selected and to be suitable material for a dam, no top

soil or fine sand to be used. This material is to be placed wet and rolled as described for trench. The material below this division may be what is left, and the stones and boulders not used in the core wall, the stones and heavy material at the bottom nearest the core wall, and the filling well rammed in between them and as soon as possible the filling to be put on in layers and rolled as above division.

Upper Slope of Dam:

This is to have a true and even slope of two to one to be covered with a layer of small stones and above that with suitable filed stone paving as sufficiently shown on the plans.

Lower Slope:

This slope is to be graded to a true and even slope of one and one-half to one and top soiled, well raked and graded and sown to grass. The level space on top of the dam will be treated in the same way.

Overflow:

This is to have a waterway 25 feet wide with side walls with dimensions as shown on the plans. These side walls are to be extended down until they reach the ledge on which they are to rest. The ledge is to be cut away to secure an even plane on which to rest the walls. There is to be a wall built lengthwise of the overflow, as shown by the dotted lines on the plans. This wall it to extend down to the ledge for a foundation. The slopes shall be paved as indicated on the plans."

Figure 12 is the section shown on the original drawings.

It calls for an earth embankment ten feet wide on top with the lower slope one and one-half to one and the upper two to one with core wall ending twenty-four feet below top of embankment.

Figure 13 shows a small amount of core wall and a spillway twenty-five feet by five feet.

The dam was built without any spillway, and Mr. Potter is said to have refused a certificate on that account. Probably the owner's theory was that a blow-off pipe was sufficient for so small a watershed. After the superintendent had spent one rainy night with the blow-off open and the water apparently just ready to go over the embankment, they put in a spillway eleven feet long and three feet high.

There was some percolation through the embankment. It was sufficient to make meadow grass grow and the ground at foot of slope was quite wet. One day a patch of soil about ten feet by thirty feet slid off the embankment so rapidly that it went on to level ground some distance from the foot of the slope, and piled itself up in a heap.

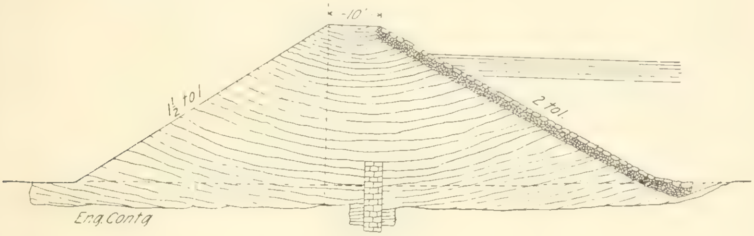


FIG. 12.

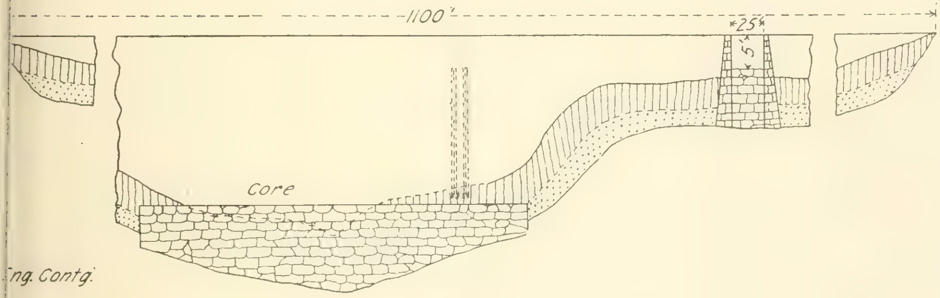


FIG. 13.

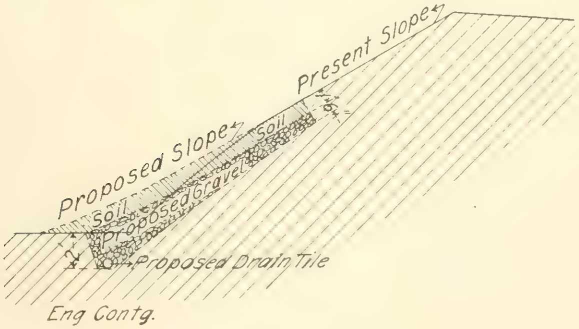


FIG. 14.

Figure 14 shows how this section of embankment was treated. The slope was flattened by the addition of six inches to two feet of very course gravel and the soil replaced. This was successful so far as making the embankment dry and permanent is concerned. The leaks were led away in a drain pipe. Experience with this dam indicates injurious percolation is liable to exist in an earthen dam without a core wall.

CONNECTICUT DAMS BUILT IN THE THIRD CONGRESSIONAL DISTRICT

While Henry T. Potter was a member of the State Board of Engineers, having supervision of dams and reservoirs.

No.	Date.	Town.	River.	Water Shed. Sq. Miles.	Rollway Opening.		Rollway Masonry.		Principal Material
					Length.	Height.	Height.	Base.	
1	1881–2	Norwich	Shetucket	1250	400	12	15½	15	Mortared rubble, concrete lining.
2	1882	Thompson	French	175	200	6	..	..	Timber rollway, earth embankment
3	1883	Woodstock	......	7	113	2½	32	30	Dry rubble, plank lining.
4	1886	Griswold	Pachaug	62	110	5	23	19	Grouted rubble, granite face.
5	1886	Griswold	Pachaug	61	111½	6	21	20	Grouted rubble.
6	1887	Griswold	Pachaug	51	120	6	15	15	Grouted rubble.
7	1888	Plainfield	Moosup	85	150	4	12	20	Timber crib, stone filled.
8	1889	Lebanon		3½	30	4	20	15	Grouted rubble.
9	1891	Norwich		¼	11	3	25	5	Earth embankment.

It is interesting to note that the eminent civil engineer who made the original plans thought it desirable to provide a spillway twenty-five feet by five feet. The experienced mill owner thought none necessary, while the engineer later consulted thought a spillway eleven feet by three feet was ample. In some cases differences in length of spillway adds very little to the cost of the dam. In this case it would add considerable. The most important difference in the ideas of the first and last engineer is in the level of the spillway in relation to the top of the embankment.

The difference of two feet makes a difference of fifteen million gallons in the capacity of the reservoir, which is quite important when one quarter of a square mile of watershed supplies three thousand people with water.

No.	Date.	Town.	River.	Water Shed. Sq. Miles.	Rollway Opening.		Capacity.	Fanning.	Differences.	
					Length.	Height.				
1	1881	Norwich	Shetucket	1250	400	12	55300	75000	−19700	
1	1881	Norwich	Shetucket	1250	400	16	85250	75000		+10250
2	1882	Thompson	French	175	200	6	9788	15000	−5212	
3	1883	Woodstock	......	7	113	2½	1487	1010		+477
4	1886	Griswold	Pachaug	62	110	5	4095	6260	−2165	
5	1886	Griswold	Pachaug	61	111½	6	5457	6180	−723	
6	1887	Griswold	Pachaug	51	120	6	5873	5300		+573 +573
7	1888	Plainfield	Moosup	86	180	4	4795	8200	−3405	
8	1889	Lebanon	......	3½	30	4	779	575		+224
9	1891	Norwich	......	¼	25	5	930	60		+870

The object of this paper is the preservation of data regarding these dams that might otherwise be lost.

A synopsis of the information herein is given in the table on page 94.

The first thing an engineer about to approve or disapprove of the plans for a dam wants to know is the drainage area of the stream, at the point where the dam is to be erected, in order that he may determine what the capacity of the rollway must be and high water level, from which he must determine the stability of the dam. The drainage area is not the only thing he must consider, but it is the most important.

The presence or absence of storage reservoirs on the stream must be taken into consideration. Aside from the storage, there is likely to be a difference of opinion as to the probable maximum flow of any stream. It may be of interest, however, to compare the provision for maximum flow made by the dams herein described, with the provision suggested in Fanning's Water Supply Engineering as shown in the table on page 95.

No correction is made therein for form of crest of dams.

THE SEA WALL IN CONNECTION WITH POWER STATIONS AND MANUFACTURING BUILDINGS.

By George A. Orrok, Mem. Conn. Soc. C. E.

The low cost of water-borne freight has been a deciding factor in the location of many industrial undertakings, and with the location came the important problem of maintaining and securing the sea wall or bulkhead against settlement and other movements tending to deform or destroy the structure.

Such important structures as power stations, grain elevators, warehouses, coal pockets, ore storage bins, etc., are usually placed adjacent to some water channel and the heavy loads on the foundations need special construction for their successful maintenance. This is more especially true where the location is on a silt-bearing tidal river, and where the tide range is large. Cheapness of handling requires that the building be located as close to the navigable channel as possible. Long conveyors consume power, transhipment from cars to boat largely increase the cost of handling, and that plant is best fitted to earn a dividend which is able to receive raw material and ship-finished products with the least expenditure of labor and power.

Power plants of any size must inevitably be located close to a water supply, both for condensing purposes and convenience in handling of coal and ashes. Many types of sea wall or bulkheads have been used in this work and the present paper is an endeavor to put before this Society a number of constructions which have been used with success, together with a brief statement of the difficulties encountered and an approximate statement of the costs involved.

Two general types of construction have been followed according to the conditions found in the subsoil. On rocky or ledge bottom, the stone retaining wall was probably first used and is a common type to-day. Where the subsoil is sand, silt or clay the pile or piles and relieving platform have generally been used. The crib bulkhead may be used on any bottom.

Crib Bulkheads: The earliest examples of this type consist of a few rough logs laid along the water's edge, the filling behind being earth and sand. Later the crib was built of rough logs, notched at the junction to form a kind of rectangular framing, weighed with stone to sink it to the bottom, the filling being rock, earth and sand as before. As the crib sank into the subsoil, additional logs were placed, building it up to the proper height. Many of these bulkheads are in use to-day and are strong and substantial. The modern crib is made of squared timber, halved together at the corners and splices, the successive courses held together with drift bolts. Mooring piles and string pieces are provided and a deck of six-inch plank is usually added.

Where timber is cheap and a good hard clay or gravel bottom may be found at a reasonable depth, the crib bulkhead is perhaps the best method of cheap construction, and in good locations its life is from fifty to seventy-five years.

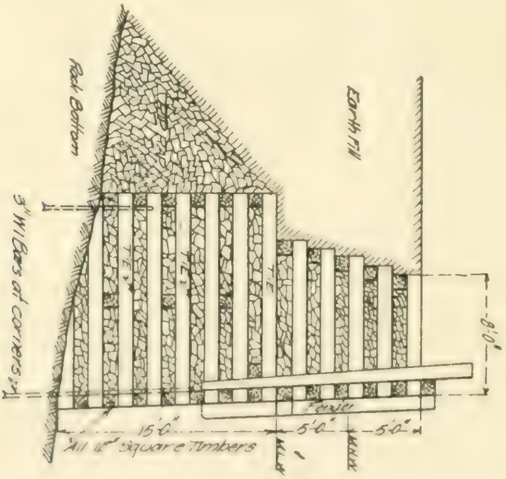


FIG. 1.

Crib bulkheads are also used on rocky bottom swept clean by swift currents. (See Fig. 1.) The cribs are built on shore with the lower courses fitted to the contour of the bottom, floated to the location, held in place by hawsers while being sunk and then anchored by drilling holes in the ledge at the internal corners of the crib for the insertion of heavy iron bars. A bulkhead of this type in good water should have a life of fifty years.

Pile Bulkhead: Where good bottom is not obtainable at seasonable depths, recourse must be had to piling, and the most ordinary form of pile wharf or bulkhead may be adopted. This consists of four or more rows of piles capped with square timber, placed at about five to eight feet apart and floored over with planking of suitable thickness. The caps extend eight or ten feet over the earth bank and the projecting ends are supported on a mudsill which also caps the short sheet piling used to prevent the washing away of the earth fill. (See Fig. 2.) A better construction caps each line of piles with six by twelve inch timbers gained into the pile head. A still better construction gains into the pile head two longitudinal caps breaking joints, the square timber cross sills being above the longitudinal caps and drift bolted to the pile heads. The deck planking should run longitudinally. Mooring piles and string pieces are provided, and in the best examples two additional stringers are run on the front row of piles and vertical plank is placed to cut off access beneath the bulkheads. The bracing of pile bulkheads may be accom-

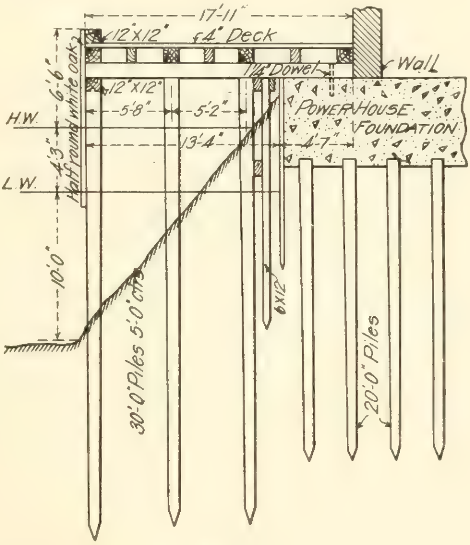


FIG. 2.

plished either by brace piles (by far the commonest way), driven at an angle, the tops sawed off and bearing against a longitudinal stringer; or by cross bracing between low water and the bulkhead deck. The latter method is much better in ordinary situations, as every pile is partially braced, while with the brace pile a slight settlement usually spoils the bearing of the brace pile and prevents its action.

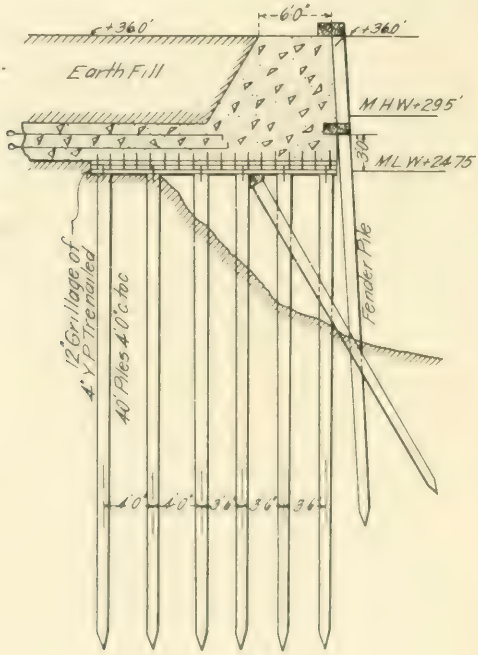


FIG. 3.

Masonry Bulkheads: For important works, with good bottom available and especially with a high range of tide levels (ten feet and above), the ordinary stone retaining wall is quite satisfactory and has been much used. This wall is usually built in sections between sheet piling, and when properly built is permanent. Sea walls of this type are known to have been in existence as early as 800 B. C. and have been in use ever since. The masonry wall is possible only when good bottom is available.

Where the tide range is small and the bottom is bad, the masonry wall may be built on a plank platform supported on piles. (See Fig. 3.) The piles are cut off about one foot below water and capped by two layers of four-inch planks laid in opposite directions and held in place by trenails. On this platform as a foundation the wall is built in rubble masonry or concrete and carried to the proper height. The plank platform should be carried ten or fifteen feet back of the wall to act as a relieving platform, preventing the thrust of the earth from coming on the piles. Brace piles are also used, a double row, two piles to every cross row. A better method is to tie the masonry wall to a bunch of piles driven in the solid earth about sixty feet back of the bulkhead by means of iron rods embedded in concrete. This method has been used a number of times and in no case has any outward movement been observed. This type of bulkhead has been criticised as to permanence, but most of the critics agree that it will last fifty years at least.

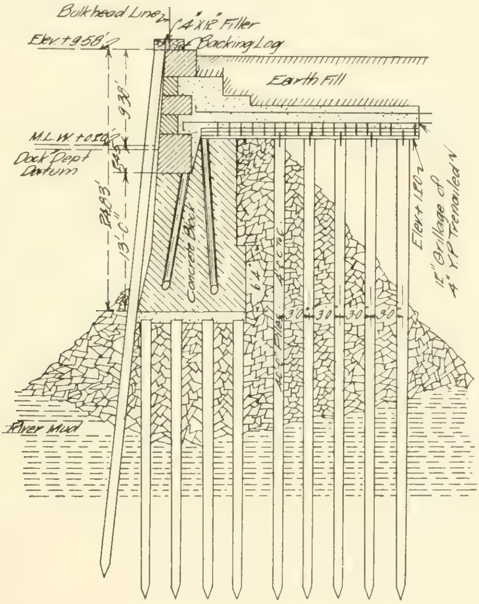


FIG. 4.

Where a more permanent and better type of bulkhead is desired, the sea wall (Fig. 4) adopted by the Dock Department of the City of New York may be used. The wall itself is made up of concrete blocks eighty tons in weight. Rows of piles about 2 ft. 6 in. center to center are driven and cut off 15 feet below

low water. These piles are covered with a mattrass of concrete in canvas bags and the blocks, which are made up on shore, are set up on the mattrass. Back of the blocks rows of piles about 5 ft. 0 in. center to center are driven and cut off at low water. These piles are capped with two layers of six-inch planking laid crossways and held with trenails and drift bolts. This capping extends over a part of the top of the concrete face block. The wall above low-water mark is built of granite ashlar backed with concrete and the filling is carried by the relieving platform. Two sets of brace piles are driven in every five-foot bay. The bottom is usually prepared by dredging to eighteen feet below low water, and after the piles are driven, sufficient riprap is dumped between them to consolidate the mud and steady the piles near their upper extremity.

This type of bulkhead is now adopted as the standard bulkhead for Manhattan Island. Where the bulkhead is loaded very heavily and the supporting piles are quite long, the tying in of the bulkhead to heavy construction further inshore has been very successful, no measureable horizontal movement having been observed in a period of five years, while in somewhat similar construction depending on brace piles, the movement in the same time has been as great as three or four inches.

Where timber is used on bulkhead construction an investigation should be made as to the presence of "teredo navalis" and "limnoria lignorum." "Teredo navalis" is a worm-shaped mollusk with a double calcareous head which works like an auger. This borer is extremely destructive in certain localities, but apparently prefers reasonably pure salt water. It is found as far north as Nova Scotia, but is much more common south of the Delaware River. "Limnoria lignorum" is a crustacean rarely over one-sixth of an inch long, which does not seem to object to sewage, but has preference for salt or brackish water. It does not appear to be so widely spread nor destructive as the "teredo" in American waters. The ravages of these marine borers appear to be confined to the portion of the pile between mean tide and about two feet below the lowest water level, but never below the mud. Creosoted timber is not affected till the dead oil is washed out by the action of the water, but untreated piles are rapidly affected. Near New Glasgow, N. S., a yellow pine pile 14 inches in diameter was observed to be eaten entirely off by the "teredo" in the course of one season. Similar occurrences are reported from various ports in the West Indies and Gulf of Mexico. At Norfolk the life of an untreated pile is only two or three years. In the neighborhood of New York the "teredo" does not flourish, due to the sewage contamination, but the "limnoria" is common and destructive. Untreated timber lasts from five to fifteen years, and much longer when protected by mud. Where creosoted timber cannot be obtained, or is too costly, the portion of the pile from the mud level to above high water is often protected by a wrapping of tar paper held in place by wooden battens, and this method is effective as long as the battens last. The best and safest method is to creosote the piles, using about twelve pounds of dead oil of coal tar per cubic foot. Concrete or tile pipes slipped over the piles have also been used as a protection.

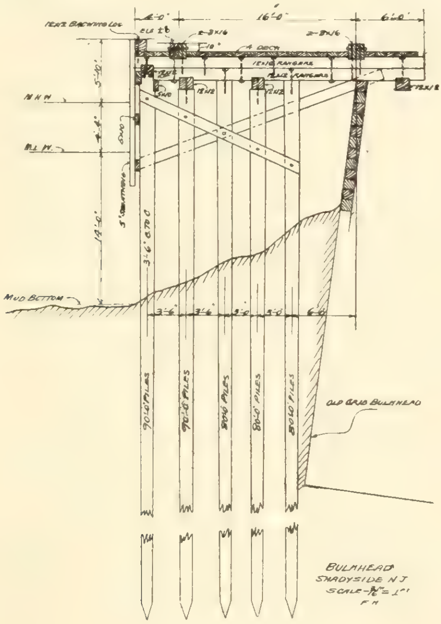


FIG. 5.

Friction-Bearing Piles: In New England waters reasonable good bottom for piles is usually to be found within a reasonable depth and piles longer than forty-five feet are seldom needed. Silt deposits are sometimes found, however, where piles over 100 feet long are needed, and in one case in my own practice we drove a pile 128 feet with a settlement of six inches at the last blow. In such a case friction-bearing piles are a necessity and four 3 in. x 3 in. strips are nailed longitudinally along the pile to give additional surface, and where a very long pile is needed, to act at the same time as splice plates. It is usual to allow from 100 to 300 pounds per square foot of pile surface in the silt for the supporting power of these piles. In the installation mentioned above (see Fig. 5), 90-foot piles were used without strips and about 250 square feet of friction surface was available on each pile. The loadings average sixteen tons per pile and no serious settlement has occurred. The ground back of the bulkhead has been loaded in excess of one ton per square foot at various times in the six years since the bulkhead has been in place and a considerable movement outwards has occurred amounting in some places to over three feet. Timber cribs twenty feet wide on the bottom, ten feet wide on top and twenty-five feet deep along the side lines of the property have been pressed outwards in some places to the extent of seven feet. That the movement comes

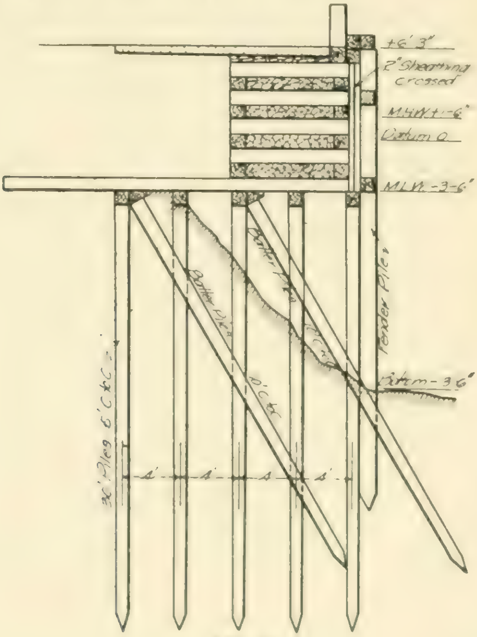


FIG. 6.

from the center of the property and much below the surface is shown, by the position taken by the face of the bulkhead and cribs, which invariably slant inwards at the top. From certain borings made on the property it would appear that solid bottom is at least 250 feet below the water level.

Where pile bulkheads are built on sand bottom, boulders are frequently encountered at such depths that piling is impossible. Where the boulder is small, six to ten feet in diameter, I have had a number of heavier piles driven surrounding the boulder, pulling the pile heads into place with chains until the riprap and grillage could be placed. Larger boulders were broken up with dynamite until a four-foot pile spacing could be obtained.

Costs: Under New York conditions the standard bulkhead in Fig. 4 should cost about $600 per running foot. The bulkhead shown in Fig. 3, and known as the Wallabout Basin type, should cost about $225. Pile and crib work depend largely on the timber cost. The First Street wall (Fig. 2) cost about $30 per running foot. The Gowanus Canal wall (Fig 6) cost about $50 per running foot. In all these examples the piles average thirty to forty foot long. The bulkhead in Fig 5 had piles ninety foot long and cost about $90 per running foot.

DISCUSSION—The Sea Wall.

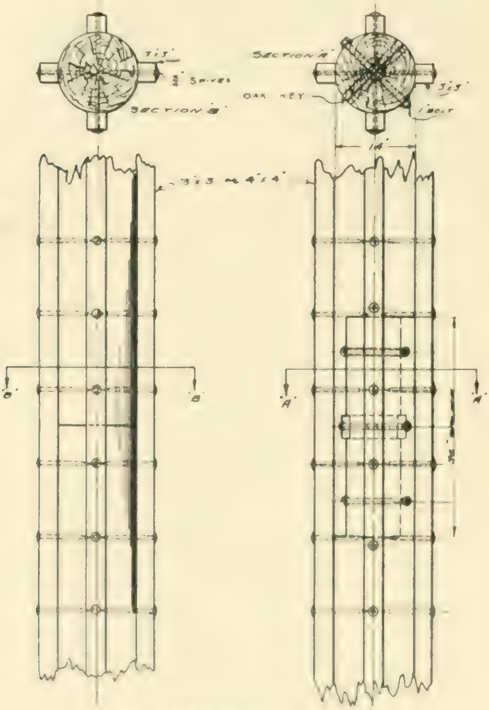
Mr. Orrok: Gentlemen of the Connecticut Society of Civil Engineers,—I intended to have a set of slides here so that you would see the construction of the bulkheads which I intend to speak upon, but, unfortunately, through a slip-up, my slides are not ready. I have, however, a couple of sets of blue prints, and these will be passed around. They will give you some idea of the difference of construction. I trust that they will, in some measure, make up for the lack of the slides.

A Member: You spoke of that standard bulkhead. What does that cost per running foot?

Mr. Orrok: The standard bulkhead costs about six hundred dollars per running foot. That varies somewhat, depending upon the price of labor and the price of lumber.

Secretary Jackson: I would like to ask one question in regard to the piles, whether they have adopted in New York any special form of splicing?

Mr. Orrok: They use the same ones that I have mentioned. Perhaps I can bring that out a little clearer if I illustrate it on the board. Sometimes where the pile is not too long these piles are sawed off square, and then four 3 x 3's or 4 x 4's are simply spiked on to the piles in that fashion, making the splice. Where the pile is longer a regular splice is made with four of these pieces which run along the side of the pile and help to strengthen it.



SPLICE FOR LONG [illegible] BEARING PILES

The President: Have you used concrete piles?

Mr. Orrok: We have used them. I think that concrete piles will be used a great deal more in the future than they have in the past. The trouble with them has been that they cost two or three times more than what we have to pay for the ordinary creosoted pile. At Coney Island, on account of the sandy character of the bottom and other conditions, some of these piles have been used. In other portions of the city it has not been thought wise to go to the expense. In places such as we have along the west shore of the Hudson River, you would probably get into trouble because the concrete piles, if used there, would have to be a hundred feet long, at least, and it is a good deal better to use the wooden piles and run the risk of the short life. There is also a probability that the concrete piles might be broken, and you would lose the advantage of it. Another thing which has to be taken into consideration is the length of time that the structure is going to be used.

A MEMBER: Has there been any effort, Mr. Orrok, to determine the difference in the life of those two classes commonly used on your bulkheads down there, or have you simply been governed in using them by the conditions existing at different localities?

MR. ORROK: Of course, that has had to be taken into consideration. The method of calculation and working out of these bulkheads is on that basis and it depends on how long you think the piles will last. If we have a situation where we are going to spend considerable money, and which requires a structure of a permanent character, why, of course, we are going to put a permanent bulkhead in, and it is sometimes better to use the more expensive type. If it is on a part of the harbor, or on one of the canals that may be materially changed in a short time, of course we govern ourselves accordingly. In those situations where it is required we put down a standard dock department bulkhead. That calls for a foundation fourteen feet below low water. Then we have probably got something which will last as long as we do, and possibly much longer. In ordinary work we must take into consideration always the question of how long the thing which we are building is going to be required or used. The question always arises how long it will be before it will be superseded by something else.

A MEMBER: The shape of those that you spoke of last has, to a considerable extent, been controlled by the difference in the designs in the new steamers, hasn't it?

MR. ORROK: That has had some effect, of course. The bulkheads are all constructed so that there is nothing behind them but solid filling, as you see on the diagram. All the piers for the big steamers are built outside of the bulkhead line. Of course, the fourteen-foot low water would not be sufficient for ocean steamers, but fourteen feet in New York is considered sufficient for all ordinary workings, for tugs, coal barges, the various car transport lines, and everything of that kind. Those boats come in at low water, and if they do hit the bottom no harm is done because the bottom is soft.

Secretary Jackson: In putting those in, do you have to build them according to the dock department design?

Mr. Orrok: When they are in the Borough of Manhattan, from 56th Street on the East River around to 100th Street on the North River, most all of the new construction in the last fifteen years has been of the type of bulkhead that I have illustrated here. I do not think the engineers will make any change in that for some time. The bulkhead has been well worked out, and it has been very satisfactory so far. When you get over on the Brooklyn shore, there has never been the same practice with reference to the use of the Borough of Manhattan bulkhead, although the City of New York owned the Brooklyn shore. Over there the main bulkheads that are of permanent construction are those which have been put in at Wallabout Basin. The bulkhead and concrete wall were built with the platform at low-water level. That same type has been put in two or three other places; at Wallabout, at the Atlantic Basin, and some other places; but in most of the Brooklyn shore work we have simply the ordinary square or round timber crib filled in with riprap, as I have shown.

Mr. Ferry: Do you have any trouble from the effect of salt water on the concrete?

Mr. Orrok: We do not have any trouble worth talking about in New York, if you get a good cement and put it in carefully. I know that there have been some instances of trouble. I know of one power station over on the Jersey side where the partition wall between the intake and the discharge for the condensing water has all become honeycombed in a matter of six or eight months, but they traced that to bad cement. I have examined some of those bulkheads that we put in six or eight years ago, and the concrete seems all right.

Mr. Wardell: What formula do you recommend for the concrete used in that kind of construction?

Mr. Orrok: That depends on your cement, on your sand, and on the situation. We use usually 1-3-5.

Mr. Wardell: Why I ask that was because I have examined the entire shore on the Sound, and I was surprised to find the condition of the concrete.

Mr. Orrok: There you strike another condition. There you get waves and ice. In New York harbor you do not have ice, to any such extent as you would outside. Then again, most concrete which was put in along the Sound is in small patches with cement picked up from small dealers, and probably they have not taken the pains with it that they should. They have had some trouble over at the Navy Yard, and I think they finally came to the conclusion that it was the cement. A cement that has any amount of free lime in it will produce those results.

A Member: You do not recommend the use of lime?

Mr. Orrok: Not for that work. Good brands of cement will work well in salt water. Concrete that has been exposed to hot salt water the longest in my knowledge is in a bulkhead on First Street in Brooklyn. It was put in since 1901. I had a man down in the tunnels the other day trying to break off some samples to show me, and he wasn't able to make much of an impression with a sledge. This concrete has been exposed to hot salt water for a matter of eight or nine years, and the concrete is still solid.

Mr. Verrill: What do you consider the average life of a creosoted pile in salt water?

Mr. Orrok: Well, I haven't seen any that have given out yet. I do not think I am old enough.

Mr. Verrill: We had a case here in New Haven which I had occasion to examine, and most of the timber was apparently as good as the day it was put in, over twenty-five years ago. That was in the early days of creosoted timber and it must have been among the first that was used in this part of the country. The only cases of failure are apparently due to cutting off the timber after it was creosoted. If the precaution is taken to creosote after it is cut off, I do not believe there would be any trouble.

A Member: I have seen instances of that. The trouble came because of the action of the water on the part that was not creosoted. The outer shell was perfect while the center was gone. If there is a chance for the water to get at the pile and wash out the creosote, why then your pile won't stand. I have seen creosoted piles that have been in twenty-five years, and they still look all right.

Mr. Verrill: That was the condition here. There was not much of it that was affected. I should say from seventy-five to eighty per cent. of it was in A1 shape.

The President: It might be of interest to the gentlemen present, if you are familiar with the method used on the extension at Governor's Island, to describe that.

Mr. Orrok: I could not say anything about that. I have never looked at the work down there. I know that type of bulkhead is the type known as the Wallabout Basin type. It is not like the type used on most of Manhattan Island.

I have mentioned in the paper here that we have been tying in our bulkheads by means of iron rods, sunk or surrounded in concrete. That is something which has interested me because I have been able to find only one mention of such a thing being done before. That was in France about thirty or forty years ago. I would like to know if any of the members here have even seen anything of the kind. In one case we had a lot of piles driven in the solid fill back of the bulkhead and tied into the piles as an anchor. We put these in, about twenty feet apart, so as to prevent the bulkhead from moving towards the water. We think that is a better practice than using the old-fashioned brace pile.

Mr. Ferry: We have built two bulkheads in New Haven which were anchored in that manner; one for the New Haven Water Company, in which the anchor consisted of a row of piles driven about 60 ft. back from the bulkhead and planked up on the back. The space between the anchor and bulkhead was filled with gravel. For the other bulkhead the anchor was of reinforced concrete. The anchor rods were wrapped with burlap soaked in coal tar, to keep them from rusting.

Mr. Verrill: There are several methods in use of tying back bulkheads. I do not think there has been a single bulkhead built within the last ten years between the Connecticut River and the New York State line that has not moved more or less. They invariably do. By tying them back you cannot entirely prevent it, but it is vastly better than building them without ties. The bulkhead that Mr. Ferry speaks of moved but very little, less than a foot, as I remember it now. So far as I know, it was very satisfactory.

Mr. Ferry: We built a bulkhead for the Gas Company using brace piles. The ground back of the wall was subsequently loaded very heavily with pipe, causing the wall to move. The wall was then tied to a concrete anchor placed about fifty feet back from the wall and since then there has been no trouble.

Mr. Verrill: Wherever that method has been used it has been satisfactory. I have in mind one case where a bulkhead not only went out but also rose about a foot and a half. The great difficulty is ordinarily in the way the filling is done. They build the bulkhead, and then they build the fill from the shore out, and it acts like a wedge. Something has got to give. If they would first put their hard filling, sand, etc., in next to the bulkhead and then work back towards the shore, the result would be a great deal better.

Mr. Orrok: There was one case that I have in mind where the Borough of Manhattan type has been used. The water where the bulkhead was built was about eighty or ninety feet deep, and it was a difficult matter to secure it properly. On that bulkhead we have a coal and ash tower which is 180 feet long, twenty feet wide, and 160 feet high. This tower stands up on edge in the air, and some of our friends were afraid that the front end of the bulkhead would sink and that the tower was going to tip over; or, if not that, they were afraid that the bottom was going out, and that the top would tip backward. I was not scared about it, but at the same time I thought I would make sure. Every few months, for the last five years, I have had a man checking the measurements, and the biggest movement we can find has been less than one-eighth of an inch. That, I am inclined to believe, is more of an error in measurements than because of any movement of the bulkhead.

A Member: I have found in just about nine out of ten cases it is the way they drive the piles. If, instead of driving the pile, they would lay them horizontally and fill in they will have a more effective anchorage to tie to.

THE WATER RESOURCES OF THE NAVAJO RESERVATION IN ARIZONA.*

By Professor Herbert E. Gregory, Yale University.

Owing to certain difficulties known to your secretary, it is impossible to stick closely to the subject assigned, and I have accordingly decided to occupy the time allotted to me in giving a geographical description of the Navajo and Hopi country.

There are two places in the United States that are practically unexplored; one of them is the region around the Bitter Root Mountains, and the other is this northeast corner of Arizona. Government parties have never been over these grounds to any extent, and you may be surprised to learn that the topographic maps of this region were made elsewhere than in the field, and that during the past summer cliff dwellings previously unknown were discovered.

The Navajo country is bounded on the west by the Grand Canyon of the Colorado, on the east by the San Juan River, on the south by the line of the Santa Fé Railroad, and extends somewhat into New Mexico. At present the Navajos have the largest reservation in the United States, and the question with the Government has been what, if anything, could be done to develop this region, to institute improved methods of farming, and to improve the district in other ways beneficial for the inhabitants. As can be readily seen, the development of this region depends upon the amount and character of the water supply.

The whole reservation contains some nineteen thousand square miles, something over twelve million acres. The distances across the reservation are therefore great. To reach the heart of the reservation from railroad points in Arizona or Colorado requires a journey of about 200 miles and access from Utah is rendered particularly difficult because of the Grand Canyon of the Colorado. Most of the supplies have to be hauled in by freight wagons for long distances. The region, as a whole, is underlaid by flat-lying sedimentary rock, chiefly sandstone with calcareous cement. The Jurassic, Triassic and Cretaceous ages are represented and marked here and there by fossil remains. These horizontal strata are deeply incised by canyons and capped by mesas and ridges extending continuously for many miles, making a tangle of cliff and gorge and butte difficult, and in places impossible, to cross. The sides of the canyons are exceeding precipitous, and although the Indians readily go up and down the walls of these canyons by means of steps which are cut into the rocks, and which have probably existed ever since the Cliff Dwellers lived in the region, a white man attempts this feat with great danger. As seen in these views [indicating] the carving of these walls taken in connection with the brown and red colors of the rock produces some of the most striking and beautiful scenery to be found in the United States.

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*This paper was profusely illustrated by slides, which it was not expedient to reproduce.

Volcanic activity has been prominent in this district from an early date, and igneous rock is present in the shape of dikes, volcanic necks and lava-capped mesas. The following views are of some of the more prominent igneous masses which have not been heretofore pictured [shows several views].

One of the notable features of the country is this natural bridge discovered last August [indicating]. This bridge, which has a height of 309 feet, and a span of 279 feet in the canyon, was probably never seen by white men before this last summer; a fact which indicates our lack of knowledge of northern Arizona and southern Utah.

This picture [indicating] shows one of the Indian freight teams which hauls material 145 miles from the railroad over roads which have been little improved. Mail from the railroad at Flagstaff is carried to Tuba, a distance of 80 miles, by Navajos, who cover the distance in two days. In getting about the country, it is necessary to travel on horseback. I tried a buckboard for a while, but the experiment was not a success and wagons were replaced by pack mules.

The animal life of this region consists chiefly of coyotes, jack rabbits, lizards, and snakes. There are no mosquitoes and very few flies. Coyotes are very plentiful and they present a serious problem to the Indian Bureau. The coyotes are increasing at an alarming rate, and, of course prey on the flocks, but the Government has taken guns away from the Indians, and without firearms the coyote can scarcely be exterminated. Herds of wild or partially wild horses are seen here and there. They are a nuisance in the region; the grass is very sparse and the horses require a large amount, thus depriving the sheep of their sustenance. The horses may be killed at the watering holes as they come to drink. This photograph [indicating] was secured by hiding near one of those water-holes and waiting for the herd to come down to drink. These wild horses are beautiful creatures, but life is too difficult, in a region like this, to spare food for useless animals.

This picture shows you the type of vegetation on the reservation. On the lands above 7,000 feet pines suitable for lumber are found; elsewhere the trees are pinons and cedars, and most of the reservation is devoid of vegetation larger than yucca and greasewood. Here is a type of landscape. It gives you a general view of hundreds of square miles of territory which you see day after day as you travel through it. That is the sort of land which we are supposed to reclaim by artesian wells or other means. Here is a type of the grass which is seen all over the southwest portion of the reservation. The Indians recognize it as excellent forage and will drive their sheep to it from long distances. One of the problems, in fact,—one of the large problems, as it appears to me,—is to get water where the Indian can use this grass. There are large areas of good feed in different portions of the reservation, which are so far from water that they cannot be used. This view shows excellent grass land near the Utah line. The nearest permanent water to this grass is eighteen miles away, a distance too great for sheep to travel between drinks. If we can find some way to secure water in those districts where the grass is good, the problem will be solved.

The people who inhabit this region are Navajos and Hopis. The semiarid and arid conditions at present prevent very general occupation of this territory. The Indians who live there have adapted themselves to the conditions, but they lead a precarious existence. The rainfall is uncertain in quantity. Heavy rains of a few hours duration may be followed by periods of complete dryness. The streams swell quickly, are full, and then as quickly subside, leaving dry beds. The soil evaporation is over six feet a year and the forest cover is so open that there is nothing to check rapid runoff.

There is no game of any account in this country, a condition which has probably prevailed for centuries. The grass is insufficient for the support of great herds of grazing animals. There is no wild fruit. There is absolutely no natural food supply. How the Indians ever lived in the country before the sheep were introduced is a question, but they probably got along with the bark of trees and with horse meat and replenished their food supply by distant excursions after game, and by stealing sheep from their more fortunate neighbors.

The Navajos are related to the Indians of Northwest Canada, and are quite unlike the usual type of American Indian in both physique and character. Notice the build and general appearance of these men just about to engage in a race. Notice also the head-dress and the clothing. They are very fond of personal adornment and highly prize silver and turquoise ornaments. If they can afford it, they decorate themselves with silver buttons, buckles, belts and headbands. Their moccasins are often covered with silver rosettes and the bridles of the horses are likewise decorated. If they cannot afford silver, cloth and other materials are used.

The Navajo woman does not require any sympathy from anybody. She lives in the original woman's suffrage community. The Navajo women have charge of their property, and absolute control of the children. In fact, the children do not belong to their father, but to the mother and her people. Provided she dies, a wife's property does not go to her husband but to her own blood relations. The arrangement for divorce is beautifully simple; the wife simply places her husband's saddle and other belongings outside of the hogan (or house) and that is the end of it. The women are not overworked. They do what they please and when they please; and practically their only generally recognized duty is to cook the food, which is a pretty simple operation. The household arrangement is that the wife looks out for the water and the husband for the wood. Then it is a constant fight as to whether the camp shall be placed near a spring or near forests.

The Navajo children are very attractive and very teachable. Notice the features and expression of this girl. Notice also her dress and these silver ornaments, which are valued above gold and the more precious stones. You can trade a silver ornament for a gold one at any time, and a diamond would be readily exchanged by them for a piece of turquoise of equal size. This girl belongs to a wealthy family and is therefore loaded down with neck chains and wrist-bands, as well as silver belt and numerous buttons.

This view illustrates the best cornfield that I saw on the reservation. The corn is about four feet high; it spreads out, you see, quite widely. They raise it for fodder and also for the corn meal. The Hopis do the principal part of the farming, but the Navajos have small fields. There is great room for improvement in the character of corn raised, for the yield is pitifully small. The problem, however, is not easily solved, for not every variety of corn is adapted to the peculiar conditions existing in that district. This particular field was planted in the "wash" between floods, and is characteristic of the whole Navajo agriculture. Plowing is not feasible, and Government farmers who plowed up the land so that the wind blew the soil away have been invited to seek a more healthy climate. The Indian method of planting is to take a sharp stick, dig a hole about five inches deep, put in the seed, then go about their business; while the corn is young they spend a little time seeing that the sheep do not get into the fields, and if there are any plants left after the floods they gather the crop. They plant a good deal in the hope of getting some, and occasionally their toil is rewarded. In recent years the acreage of corn land has decreased because of the washing of the alluvial bottoms. This is especially disastrous for the Hopis, who depend almost wholly upon corn for their food supply. At the present time nearly one-half of these Indians are without arable land. How to prevent the removal of soil is an engineering problem of considerable moment. Some of the floods which sweep down valleys cover very large areas; occasionally the washes are occupied by sheets of water one to two miles wide, and from an inch to six feet deep. Moreover the channel may change with each season, burying fields with an immense amount of material which varies in texture from the finest silt to bowlders of adobe and sand. A check dam built in these washes would be useless after a single season.

In distinction from the Hopis who are agriculturists, the Navajos are sheep men at the present time. The type of sheep which they raise is shown in this view. The Navajo sheep have long legs and they produce a coarse wool suitable for making

Navajo blankets, but which commercially is used only for carpets and rugs. Sheep are, in many respects, the salvation of these Indians. Mutton is the chief article of diet and the sale of wool and blankets is the Navajo's only source of income. Efforts have been made to introduce better sheep, so far without success, because the finer-bred sheep of other localities can not travel the long distances necessary to secure water. These people are naturally nomadic in their habits, and the sheep-raising business is thus a good thing for them. My own notion is that it would be beneficial to the whole country if improvement could be made which would allow a much greater extension of this industry. The missionaries want the Indians to establish themselves in small villages, presumably so that they may reach them more readily. It seems to me that the better way is to recognize the peculiar qualifications of the Navajo and of his country and to encourage the raising of stock.

The Navajo has no superior as a horseman. He will ride any horse, wild or tame. A child of eight years will be put on a broncho without hesitation. The Navajo seems to understand a horse intuitively. It makes very little difference how the horse is equipped—with an army saddle, a Mexican saddle, an English saddle, or, in fact, without any saddle at all. The animals are so plentiful that little affection is bestowed on a particular horse. They have been known to ride one horse until it dropped, then leave it, find another somewhere and go ahead with that. The Indians we had with us started with two horses apiece, and whenever we needed another horse one was picked up somewhere. These horses are very hardy and well adapted to the country. They are ridden up and down through this hot, dusty country, through the quicksands and over rough places, without food and without water for long stretches of time, and their endurance is little less than marvelous. The saddle horse is the only means of travel practicable for this country, and it is fortunate that the supply is plentiful and cheap.

Here is one of the Indian trading stores. It is a rather unpretentious affair, but is the center of the wool and blanket industry for an area larger than the state of Connecticut, and is the only store within this area from which the Indians may obtain supplies. The business done with the Indians at this trading post this last year amounted to six hundred dollars a month, in addition to thirteen thousand dollars worth of blankets sent to the railroad. This entire place, including a large herd of sheep, is supplied with water flowing through a one-inch pipe!

This is a picture of a Navajo silversmith, busy at work making rings and necklaces out of Mexican dollars.

The view now on the screen is that of a Navajo chief, one of the most distinguished persons on the reservation. It is remarkable to see the allegiance yielded to these old men. I really believe if that man should ask half of the Indians to leave the reservation to-morrow, the answer would be 'Shall we start at six o'clock, or at eight o'clock'? The power of such a man excites more interest when it is realized that the Navajos have no tribal organization, regular council, nor hereditary chiefs. The influence of a chief or medicine man is merely that of a strong good man over a group of people of which he is one. The trust in these leaders may be illustrated by the following example: There was an Indian on the reservation who was wanted by the Government. The troops sent to capture him had been surrounded and disarmed. More soldiers from Fort Wingate were sent out, but the Indian agent had sense enough to keep them away from the Indians. This old man was called in and the case explained to him. He said, "All right, we will bring him in"; and sure enough, the man was surrendered at the exact place and time agreed upon. You will readily see how essential it is to establish friendly relations with these men. While the head men are honest, the young men are not. They will steal any little thing you have. If you have a whip lying around the camp you must watch it or it will be gone. They will crawl around a store and reach for anything they can get their hands on, and if they can get ahead of you in some small way they will not hesitate to take the chance. But, on the other hand, if you give one of these men a thousand dollars and ask him to take it to Albuquerque, he will take it there without the loss of a cent.

This is the house of a Navajo Indian. These Indians have two residences: this is the winter house, and this the summer. Occasionally they have both at the same place; often the summer house is near the crop and the winter house near some timber for fuel; sometimes they are midway between. On the interior these hogans are perfectly plain; nothing but meat hanging up, and here and there a few blankets to sleep on.

One of the tasks intrusted to me was to pick out sites for tuberculosis camps. This is the disease which carries them off by the hundred, because of the lack of proper medical attention and sanitary measures. This picture represents a sweat house, used as a cure for most diseases. Heated stones are put inside, water is poured upon them, then the patient enters to take a Turkish bath. They come out, and rub themselves with anything handy, and the cure is presumably complete.

This is another method of curing disease—a "singing." This group of people have gathered about to participate. This sick man is rich enough to have an elaborate ceremony, and inside of the house the medicine men are chanting formulas that require years to learn, and which are entirely ineffective if a single syllable is misplaced or mispronounced. If you want to go in there you are invited to stay out.

You may travel for months on these reservations and never see a grave. Where do they bury the dead? They hide them. The house in which you die is burned or abandoned, and everything you have left is tabooed. If you see a dead body it is necessary for you to move, and so some especially chosen people have to carry the bodies away and hide them. Here is the only Navajo grave that I had called to my attention. You see it is hidden under this rock. I am told that corpses are thrown down into the cracks between rocks, buried in the sand, and hidden under bowlders, and yet it is strange that so few remains of the thousands and thousands of Indians who must have died in this region have ever been located.

The descendants of the old Cliff Dwellers now live among the Navajos but in villages located like this [indicating]. It is almost impossible to find these groups of houses unless you know of their existence. This village has three hundred inhabitants. A small one nearby has one hundred and fifty. The houses are constructed with a special intent to deceive. Notice how they are located high in the rocks, away from the water supply. That is one of the problems which we are called upon to study. There is water down at the base, and the women are required to carry the water from here to the top, and in the dry season they may carry it from springs several miles distant. The Government has tried to induce the Hopis to come down from their rocky fastnesses and live at the foot of the mesas, but so far without success.

One of these villages gets its whole supply from a spring which showed a flow of about a pint a minute. Shortage of water in Connecticut would mean a surplus in this region. Notice the method of reaching these villages built at the edge of a cliff. The inhabitants are well protected from marauders. Here is the village from the interior, showing the type of houses, all built of stone, with a court on top.

This is a picture of Hopi Indians. The Navajos call them "Moquis," which means "dead ones." One remarkable thing about these people is the distance from which they bring their grain or corn. They think nothing of cultivating fields which are six to ten miles away from the village. The Hopi travels that distance back and forth every day, usually afoot. They think nothing of a walk, or rather a trot, of fifty miles; on one occasion a Hopi selected at random covered a distance of 120 miles in twenty-four hours and delivered a message.

This view shows one of the best peach trees in Arizona. When the trees are small a little fence is built around them to ward off drifting sand. Rainwater goes down into the sand for a few inches and furnishes sufficient moisture for the trees. In some cases the saturated zone will extend downward for three feet, below which point the sand is again dry. Notice this crop of melons. Melons, peaches and corn are the staples of Hopi agriculture.

Now follow a few pictures of Hopi women and children. There is not much intermixture of races and rules are enforced regarding marriage outside of a given religious fraternity. These people believe in children, and families of ten or twelve are not uncommon, but it is rare, however, that more than one or two of them live beyond childhood. Here is a little boy going, as you see, perfectly naked. That is the fashion through that region. This picture shows a typical family scene. Notice the clothing. Most of the Indians have one blanket, or if they can afford it, two blankets sewed together; occasionally there is an additional outside blanket.

One of the things which interested me was to see how the habits of life, as well as the religious customs, had been developed by the fact that water was scarce. This scene depicts the well-known custom among the Hopi of holding a snake dance. This dance is really a prayer for rain, and the Indians work at it religiously, for they say "we must have rain and the rain-god must be propitiated." Sometime in August or early autumn, the chief men begin to prepare for the snake dance. Previous to that time the snakes have been collected from all over the country and brought together in one place. I will not take the time to go into a description of this ceremony although it is very interesting. Here are some of the snakes on the ground and the picture shows you the method of picking them up and of holding them. Here are some of the priests with snakes in their mouths, and this man has an armful of these reptiles. After the snake dance, purification is necessary and the priests drink an emetic which produces the usual result. Here is one of the Hopis just after the dance. He is getting ready to make a run out across the country. These runners take the snakes to the four corners of the world and leave them there with a message to the gods that rain is greatly needed for the cornfields.

The rainfall in the Navajo reservation comes mainly in the summer after the growing season. Here are the figures for Fort Defiance: total rainfall, 11.3 inches; spring 2.48, summer 4.47, autumn 2.93. At Keams Canyon in the center of the reservation the annual rainfall is 13.40 inches, divided as follows: winter 5.11, spring 1.97, summer 3.16, fall 3.16. On the western side of the reservation at Tuba the records show 6.28 inches, less than one-tenth of an inch coming in the spring. Ordinarily the months of April, May and June, the growing season, have no rainfall. Extensive agriculture is therefore impossible.

That this region was formerly better watered might be inferred from the numerous ruins widely scattered over places now arid. The source of the supply for these ancient people is not always evident. Probably they got water from the sand in the wash during the flood season, and stored it up for use in the dry season. They may have had wells, and certainly some of the springs from which a supply was drawn have since been concealed by accident or design. Here is a picture of one of the old springs which we recently discovered. The seepage from this spring had been carefully concealed so that no water flowed at the surface. At present the water supply is ample for six or eight hundred people. This picture shows an ancient irrigation ditch cut in the rock, and located where there is no water at present.

So deficient and irregularly distributed is the rainfall that the only river in that entire region which runs throughout the year is the San Juan, of which this is a general view. The river is not easily crossed except at low water. When we crossed in July it was necessary to swim the horses and to build a raft with which to take the Indians across. Back some distance from the San Juan river successful artesian wells have been sunk, particularly in the district about Bluff.

This is the Little Colorado River. This picture was taken about the 10th of May. In June not a drop of water was seen at this point; in August the valley is full from bank to bank.

I want to call your attention to these pictures showing the suddenness with which the water rises and passes down through the wash courses. This was taken on Monday, and this picture [indicating] was taken on Thursday. This view shows some of the stuff that came with the flood, rolled out on the field which is perfectly flat, so you can get some notion as to the character of the material.

The test well illustrated here is sixty-four feet deep. From it is obtained a large supply of water for a new Indian school. Some of the wells planned are quite large. This one, for instance, is twelve feet in diameter and fifteen deep, and supplies the buildings of a Catholic mission. I have recommended the sinking of wells thirty or even forty feet in diameter. More water must be secured if any considerable population is to be maintained in this region. Large irrigation projects are not feasible, for they have the disadvantage of giving a larger amount of water where water exists already, instead of giving some water where there is none. We hope by means of wells, springs and cisterns of Bermuda type to make life easier in this district. The plan is, if possible, to get a small supply of water about every five miles over the entire area, so as to develop the region as a grazing country. The engineering problems involved are being worked out by the engineers of the Indian Service.

GEORGE H. BISHOP.

In Memoriam.

Mr. George H. Bishop, one of the older members of the Connecticut Society of Civil Engineers, died of paralysis, August 19, 1909, at the New Watch Hill House, Watch Hill, R. I. He was born in Middletown, June 11, 1831, and was more than seventy-eight years old at the time of his death.

Mr. Bishop began his engineering career as a subordinate under Mr. Edwin F. Johnson in the first survey for the layout of what is now known as the Air Line Railroad, on that portion of the route between Middletown and Willimantic. Later he was employed on the layout and construction of the Middletown Branch Railroad, between Middletown and Berlin, and on the main line of the New Haven, Hartford and Springfield Railroad. In 1856, when Mr. Edwin F. Johnson was mayor of Middletown, Mr. Bishop made the surveys, general maps and profiles of the streets of the eastern portion of that city for the purpose of establishing lines and grades for roadways and curbs. During several years after that date, whenever the services of an engineer were required by the Common Council or its committees Mr. Bishop was employed. He was also a County Surveyor for Middlesex County.

When Middletown had been decided upon as the locality for the State Hospital for the Insane, Mr. Bishop was employed to survey the large tracts of land given by the town of Middletown, and acquired by purchase for the Hospital, and he also laid out the original building for that institution. He was the engineer of its first water supply, and was also connected with four other reservoirs subsequently constructed for that institution, either as engineer or consulting engineer.

In 1866 he designed and had charge of the construction of the Laurel Brook water supply system for the city of Middletown, and again in 1895 he selected the site for the reservoir and dam of the Higby Mountain high pressure system for Middletown, and he was the chief engineer in charge of its construction. In 1869 he designed and supervised the construction of the first water supply for the city of Meriden, Conn. He was afterwards located in Boston, and had an office at 57 Tremont street. He was the engineer of the water supply systems of several cities of Massachusetts, Lynn, Taunton, Gloucester, and probably others. He was frequently called as an expert regarding water rights, and as consulting engineer. At one time during the earlier history of the Air Line Railroad Mr. Bishop and Mr. John N. Camp of Middletown were appointed trustees of that railroad. It was successfully managed by them during a critical period of its financial affairs.

Mr. Bishop married, March 10, 1869, Miss Ella P. Purple of Chicago, Ill., who died a few years afterwards without issue, and he never married again. He retired from active engineering work about twenty years ago. He was fond of boating, and for some years owned a steam yacht, "Engineer," on which he spent much of the summer months.

Mr. Bishop was prominent in Masonic circles, having joined St. John's Lodge, Middletown, Conn., Feb. 12, 1858; Washington Chapter, No. 6, R. A. M., April 20, 1869; and Cyrene Commandery, No. 8, K. T., Nov. 15, 1869. He was elected Master of St. John's Lodge, December 21, 1860, and again, December 18, 1863. At the time of his death he was the oldest past master of St. John's Lodge.

Mr. Bishop was a member of the American Society of Civil Engineers, and of the New England Water Works Association. He was also one of the original members of the Connecticut Society of Civil Engineers. He was a man of retiring habits and disposition, who avoided rather than sought prominence among his associates, and for that reason probably was not very well known by many of the members of this Society.

E. P. AUGUR, } *Committee.*
S. C. PIERSON, }

WALTER A. BROWN.

In Memoriam.

Mr. Walter A. Brown was born in Lowell, Massachusetts, August 26, 1869, the son of Daniel Warner and Emma Ellis Brown. When eight years of age his parents moved to Feeding Hills, Mass., where he lived until he entered the Massachusetts Agricultural College in 1887, graduating in 1891. For a short time following his graduation he was employed by the Lehigh Valley Railroad in the office of the Chief Engineer at Bethlehem, Penn.

In 1892 he entered the City Engineer's office in Springfield, Mass. and in 1900 was appointed to the office of First Assistant City Engineer. In 1907 he resigned from the Springfield office to take the management of the office of the Clapp & Abercrombie Company in Greenfield, Mass. While in Springfield he passed several government civil service examinations and was offered by the government two positions, one in the Philippines, the other in the Hawaiian Islands, both of which he declined. His profession was to him a deeply loved and facinating study in all the branches in which he was interested, municipal improvements and landscape architecture especially claiming his attention.

He was married in 1897 to Steela H. Price of Iowa City, Ia., who with three children survive him. He was a member of the North Church, Springfield, and was an active worker there, and wherever he lived, in all the branches of church work. He became a member of the Connecticut Society of Civil Engineers October 11, 1902.

E. E. Lochridge, } *Committee.*
M. W. Denman, }

COLONEL SMITH S. LEACH.

In Memoriam.

Smith S. Leach was born in Indiana, April 27, 1851. He entered the U. S. Military Academy at West Point as a cadet, July 1, 1871, graduated at the head of his class and was promoted in the army to Second Lieutenant, Corps of Engineers, June 16, 1875. His subsequent promotions, all in the Corps of Engineers, were as follows: First Lieutenant, March 4, 1879; Captain, September 30, 1884; Major, February 5, 1897; Lieutenant Colonel, September 14, 1904; Colonel, June 2, 1908; Acting Chief of Engineers, May 25–July 8, 1908.

His first assignment to duty, after graduation, was with the Engineer Battalion at Willets Point, N. Y., where he was stationed from October 1, 1875, to July 16, 1878, with the exception of a temporary tour of duty for about four months at Philadelphia in 1876, in connection with the International Exhibition, and a short assignment to special service at Baltimore in 1877. While at Willets Point he was Adjutant and Treasurer from September 14 to December 11, 1876.

After leaving Willets Point he served as Recorder of the Board of Engineers on the improvement of low-water navigation of the Mississippi and Missouri rivers for about a year and was then made Secretary and Disbursing Officer of the Mississippi River Commission; which position he held until March 3, 1885, and again from April 14, 1887, to March 17, 1888. On March 10, 1885, he was placed in charge of the improvements of the Second, and shortly afterwards also of the First, District of the Mississippi River, where he remained until March 26, 1888, when he was assigned to duty as Assistant to the Engineer Commissioner of the District of Columbia for about two months. After this detail he was again placed in charge of improvements of the Mississippi river, with station at Memphis, where he also had charge, for about two years, of the bridge across the river at that place.

This assignment lasted until July 3, 1890, when he was ordered to Boston as assistant on the defenses of that harbor, which position he filled until he was placed in charge, December 10, 1892, of Fort Montgomery, N. Y., and of the river and harbor improvements on Lake Champlain and the St. Lawrence river, with office at Burlington, Vt.

He left Burlington to take charge, August 1, 1896, of the Connecticut District, embracing the defenses at the eastern entrance of Long Island Sound and the river and harbor improvements in this State and the Pawcatuck river between Rhode Island and Connecticut. While in this district his office was in New London, where he also resided until relieved, January 7, 1902, by the late General Charles F. Powell.

After leaving New London, Colonel Leach was Engineer Officer on the Staff of the Commanding General of the Department of the Missouri from February 28, 1902, to January 15, 1904. He was then placed in command of the First Battalion of Engineers at Fort Leavenworth, Kansas, until November 12, 1904, when he was transferred to the District of Columbia and placed in charge of the Washington Aqueduct and the river and harbor works at Washington.

From that time his station remained at Washington; in charge of the last named works until July 31, 1905; as Member of General Staff Corps July 24, 1905, to July 1, 1907, and for the remainder of his life as Assistant to the Chief of Engineers. While holding the last named position he was also Acting Chief of Engineers from May 25 to July 8, 1908, and Member of the Board of Engineers for Rivers and Harbors from July 9 to September 16, 1908, and from March 31, 1909, to the date of his death, which occurred at Washington, D. C., October 16, 1909, after a prolonged period of ill health. A widow, but no children, survives him.

During his career of nearly thirty-five years as an engineer officer, Col. Leach had charge of and planned many important works, both military and civil. Among others, the Washington filtration plant was completed and actual filtration was begun under his direction; but probably his most important work as an engineer was done in this district and especially in connection with the defenses at the eastern entrance to Long Island Sound.

Previous to the time when Col. Leach took charge of this district it had been included in a larger one, which also embraced a large amount of work in New York State, including all river and harbor improvements in Long Island, a number along the northern side of the Sound to the westward of the Connecticut line, and many of the fortifications in the vicinity of New York City, where the office was located. Up to this time no modern works of defense had been built to protect the eastern entrance to Long Island Sound and no fortifications worthy of the name existed anywhere between Willets Point and Newport.

Shortly after Col. Leach assumed charge, modern fortifications were begun on Gull Island and Plum Island, the work being done by contract. Before these works were completed the Spanish War began, additional forts and batteries were commenced and the work on all was rushed as rapidly as possible. All work on the new fortifications was by hired labor, and it was here that Col. Leach displayed his great executive ability, energy and push. The emergency demanded, not only an able engineer, but also a man of great business ability, and Col. Leach was such a man. He promptly cut through all needless red tape and personally took charge of ordering the immense quantity of material needed at once, doing much of the business by that modern timesaver, the telephone. For anybody who was not then connected with the work it is hard to realize the difficulties with which he was beset. Similar work was in progress or being begun in numerous other places and men and material were hard to get. The work had to be done in four different places, three of them islands, and it was necessary to not only secure the necessary men and material but also to provide transportation for both and to house and feed the men. Two of the islands were uninhabited and on the third there were only a very few small private houses. Even fresh water for the men and boilers had to be carried by boat to most of the works. Wharves, storehouses, quarters for the men, etc., all had to be built and the entire construction plant purchased, assembled and set up, and all with the utmost possible dispatch.

Col. Leach promptly organized an engineer force, adding to his regular force, which was much too small for the emergency, a number of men who had been engaged on private work, and his orders to all were to rush everything to the limit. Work was carried on night and day with two shifts of men, but men were scarce and it was necessary to work many of them more than their regular shift of ten hours, in fact many put in fifteen hours out of the twenty-four and some even more. Col. Leach himself visited the works nearly every day and frequently at night and more than once remained all night; nor were his visits merely superficial inspections, for he kept thoroughly familiar with the work, even to the details, and he was insatiable regarding the amount done. The writer well remembers, once, when in answer to an inquiry, he told Col. Leach that the estimated daily output of concrete had been more than doubled and added that he hoped the Colonel was satisfied; but the reply was, "Mr. Verrill, there is no use in trying to satisfy me,—no matter how much you do I shall want you to do more." With this feeling he animated all the men, but at the same time he looked to their welfare and comfort in every way possible. Notwithstanding the rush, the work was well done, much better than the contract work that had been done more deliberately; and in spite of the fact that for months together the men never left the island and worked every day, Sundays and holidays included, the writer never heard a complaint from any of the engineer force. This alone bears testimony to the respect and esteem in which Col. Leach was held by all his assistants. Before these forts were entirely completed the war closed, but additional works were begun, including those on Fishers Island, and fortification work was still in active progress when Col. Leach left this district. Many of the members doubtless remember the visit which the Connecticut Society of Civil Engineers made to Fort H. G. Wright, by Col. Leach's invitation, in 1901, and such as were present can perhaps appreciate the many difficulties of building such a fort on a barren island and under the conditions with which Col. Leach was confronted when the war began.

In addition to the fortifications Col. Leach had charge of a large amount of river and harbor improvement in this district. The existing project for the improvement of New Haven harbor, now very nearly completed, and which has cost about $300,000, and the project for improving Bridgeport harbor, which was practically completed in 1907 at a cost of about $200,000, were both adopted on the strength of his reports and recommendations and were the first projects in this district to be carried on under the continuing contract plan, by which a contract is entered into for the entire work and the necessary funds, after the beginning, are appropriated as needed in the Civil Sundry Bill, instead of letting a number of smaller contracts from time to time as the money is appropriated in the River and Harbor Bills.

Col. Leach also submitted very able and comprehensive reports on surveys of the Connecticut and Housatonic rivers and presented revised projects for the improvement of these streams, although these projects have never been adopted. A number of other projects for the improvement of smaller harbors in this district were also originated by him and several of them have been since adopted and completed or nearly so, among which are the projects for the improvement of the harbors of Branford, Milford and Southport.

Plans for various important private works in this district, built under permit from the Secretary of War, were approved by him and their construction carried on under his supervision. Among these may be mentioned the Chapel street bridge across Mill river, built by the City of New Haven, and the N. Y., N. H. & H. R. R. bridge at Bridgeport.

In addition to his regular work as an engineer officer, he was the author of the Engineer Field Manual, officially adopted for the U. S. Army, and was one of the authors of the Standard

Specifications, adopted by the Corps of Engineers, for cement and for electrical equipment of seacoast defenses.

Col. Leach was naturally particularly well qualified for an engineer officer, possessing in a remarkable degree executive and business ability, energy, quick perception and firm decision. He took great interest in his work, visiting it frequently and keeping in close touch with it at all times, but not hampering his assistants by unnecessary instructions with regard to details. He knew exactly what he wanted done and his official letters were remarkably concise and to the point; his decisions once made were seldom changed, never without sufficient reason.

Personally he was universally liked and respected, not only by his assistants but by the contractors, business men and others with whom he came in contact, both officially and socially. He required from his assistants the most implicit devotion to the work and from the contractors the most faithful performance of their contracts, but nobody grumbled for they all knew he required no more from them than he gave himself, and the writer does not remember of ever hearing anybody speak disparagingly of Col. Leach. On the other hand, everybody felt deep regret when he left the district, and he himself was loath to go. The writer still carefully preserves a letter he received from Col. Leach just before leaving, which shows better than anything else his character and his feeling towards his men. He says: "It is a source of comfort and pride to me to know that, after several years of association in work, I retain the good will of men from whom I have always exacted—what I give myself—absolute devotion to the interests of the United States, with all the sacrifice of personal convenience which that devotion implies.

My regrets in leaving this work are small as compared with my regret at parting with the men who have helped me do the work."

The accompanying portrait of Col. Leach is from a remarkably good photograph which he gave the writer when he left the district. It was taken at that time, and for this reason it is thought that it will be of more interest to the members of this society than a later picture, as it shows him as he looked when most of the members knew him.

Col. Leach was elected a Member of the Connecticut Society of Civil Engineers, January 8, 1901.

George E. Verrill, } *Committee.*
George K. Crandall, }

ABSTRACT OF THE PROCEEDINGS

AT THE

TWENTY-SIXTH ANNUAL MEETING

OF THE

Connecticut Society of Civil Engineers.

The twenty-sixth annual convention of the Connecticut Society of Civil Engineers was called to order at North Sheffield Hall, Yale University, New Haven, Connecticut, Tuesday morning, February 8, 1910. President Easterbrook in the chair.

It was voted that the minutes of the last meeting be accepted as printed in the annual report.

The report of the Board of Direction as read by Secretary Jackson was adopted.

REPORT OF BOARD OF DIRECTION.

"At a meeting of the Board of Direction held in Pythian Hall, Hartford, February 9, 1909, the resignations of Frank N. Hoyt, Theodore A. Curtis and Louis Hudson were accepted, John Buddington and Fred H. Parsons were dropped from the rolls, and the following applications for membership were approved: Gardner G. Riggs, Waterbury, Conn.; Frederick G. Patience, New Britain, Conn.; George A. Orrok, Flatbush, New York; Carroll A. Campbell, West Hartford, Conn.; George B. McConnell, New Haven, Conn.; James L. McElroy, Bridgeport, Conn.; Rawlins Lowndes, Waterbury, Conn.; Everett W. Lewis, New Haven, Conn.; Andrew A. Canfield, Bridgeport, Conn.; Richard L. Saunders, New Britain, Conn.; Rodney B. Miller, New Haven, Conn.; Nathan J. Gibbs, Norwich, Conn.; Remsen B. Cole, Jr., Waterbury, Conn.; Herbert V. Olds, Hartford, Conn.; William H. Kershaw, Bridgeport, Conn. For associate membership, William F. Hickey, Boston, Mass.

Present: Messrs. Bush, Kellogg, Punderford, Chase, Easterbrook and Crandall.

At a meeting July 9, 1909, held at Cox's, Savin Rock, it was voted to hold the summer meeting at Stony Creek, August 17, 1909, the arrangements to be left to a committee to be appointed by the President. It was voted to close the books of the Society on February 1st of each year.

Present: Messrs. Easterbrook, Punderford, Ferry, Palmer, Crandall and Kellogg.

At a meeting held at Stony Creek, August 17, 1909, the resignation of Clifford Belden was accepted. The following applications were approved: Frank R. Bartlett, Torrington, Conn.; Robert D. Beardsley, Naugatuck, Conn.; Charles D. Curtis, Naugatuck, Conn.; George H. Curtiss, Waterbury, Conn.; George C. Ham, Naugatuck, Conn.; Henry McBurney, New Haven, Conn. For associate membership: Charles E. Hubbard, Hartford, Conn.; Robert B. Tracy, Waterbury, Conn.

Present: Messrs. Easterbrook, Bush, Kellogg, Punderford and Ferry.

At a meeting January 8, 1910, in City Hall, New Haven, the ballots for nomination for officers for 1910 were canvassed with the following results:

President, Shepard B. Palmer, Norwich.

First Vice-President, Charles A. Ferry, New Haven.

Second Vice-President, A. William Sperry, New Haven.

Secretary and Treasurer, J. Frederick Jackson, New Haven.

Board of Direction, John K. Punderford, New Haven; George K. Crandall, New London.

George B. Palmer and H. B. Hurlburt were dropped from the rolls.

Messrs. Verrill and Crandall were appointed a Committee on Necrology for Smith S. Leach, and Augur and Pierson for George Bishop.

Present: Easterbrook, Crandall, Kellogg and Ferry.

(Signed) F. J. EASTERBROOK,
GEO. K. CRANDALL,
HENRY J. KELLOGG,
EDWARD W. BUSH,
CHARLES A. FERRY,
SHEPARD B. PALMER."

The following report by Secretary Jackson was adopted:

REPORT OF SECRETARY.

"*To the Officers and Members of the Connecticut Society of Civil Engineers:*

Your Secretary respectfully submits the following report:

In June sixteen hundred copies of the twenty-fifth annual proceedings were printed and distributed to the members, to those societies with whom we exchange, and to different libraries and institutions of learning.

The Society held one additional meeting on August 14 which was somewhat marred by the heavy rain, though all who had the courage to attend voted unanimously that it was the best meeting of the Society they had attended.

The Secretary has during the year attended the different meetings of the Board of Direction; has had printed and distributed notices of the different meetings, bills for dues and advertising, and the ballots for nominations and election of officers. The canvass for nominations resulted as stated in the report of the Board of Direction.

During the year twenty-three new members have been elected, twenty active and three associate; four active members have resigned, four active and one associate have been dropped, and three active—George H. Bishop, Smith S. Leach and Walter A. Brown of Springfield—have died.

The membership February 7, 1910, is as follows:

	Feb. 8, 1909	Elected	Resigned	Dropped	Died	Feb. 7, 1910
Honorary	12					12
Active	266	20	4	4	3	275
Associate	8	3		1		10
	286					297

The following report of the Treasurer was adopted:

REPORT OF THE TREASURER FOR THE YEAR ENDING FEBRUARY 1, 1910.

J. Frederick Jackson, Treasurer, in account with the Connecticut Society of Civil Engineers.

RECEIPTS.

To cash on hand February 8, 1909	$243.18
Received discounts on bills for advertisements, 1909	15.88
Received from advertisements, 1909	541.61
Received from back dues	111.00
Received from dues, 1909	378.00
Received from dues, 1910	216.00
Received from dues, 1911	3.00
Received from sale of dinner and lunch tickets	217.50
Received from sale of proceedings	4.00
	$1,730.17

DISBURSEMENTS.

By Expressage	$ 65.30
Freight	10.14
Expense annual meeting	168.00
Postage	7.92
Printing, stationery and supplies	805.77
Rent of P. O. Box	7.50
Engraving	58.70
Services of stenographer	50.50
Summer meeting	150.25
Transportation	1.75
Salary, Secretary, 1908	150.00
Cash on hand	248.25
	$1,730.17

REPORTS OF SPECIAL COMMITTEES.

The Committee on Pin reported, submitting three designs for the consideration of the Society.

After considerable discussion it was voted that the matter of the pin be referred to the meeting this evening, and that the cards containing the designs be numbered and passed around among the members, and that a ballot be taken this evening expressive of the opinion of the members whether they wish a pin or not, and if a pin, then which one of the designs presented they favor.

To the Connecticut Society of Civil Engineers:

Your committee appointed at the last annual meeting to consider the matter of obtaining better descriptions of land in deeds of transfer of title, beg leave to report as follows:

In the discussion preceding the passage of the resolution for the appointment of a committee, frequent reference was made to the so-called "Torrens" law. As this law may afford a means by which the object desired can be obtained, and as some of the members of the Society may not be familiar with its provisions, it may be well to give a summary of it.

This law receives its name from Sir Robert Richard Torrens, by whom it was devised and under whose supervision it was first put into operation in South Australia. The law first went into effect July 1, 1858; it has therefore been in practical use for a little over a half century. It is modeled on what is known in English law as the "Merchant Shipping Acts," under which the transfer of shares in ships was accomplished in a manner similar to that in which transfers of stock in corporations is conducted at the present time.

It has been called a "system of conveyancing by bookkeeping attended to by a clerk," and, as originally conceived, this well expresses the end contemplated. In the effort, however, to meet the various legal technicalities which have arisen in practice, an elaborate code has been built up which, in the case of the law recently adopted by the state of New York, covers fifty-five pages of typewritten legal cap, so that it has been ironically called "a system of land transfers by law suits attended to by lawyers."

Previous to 1907 the Torrens system had been adopted in the British provinces of South and Western Australia, Tasmania, Queensland, New South Wales, Victoria and the Canadian provinces of Ontario and Manitoba. In the United States, Illinois was the first to adopt the system, the law being adopted there to meet conditions caused by the burning of the official land records of Chicago in the "big fire," and the monopoly created by a company of conveyancers who were fortunate enough to possess abstracts of the records.

The other states which have adopted the system are California, Massachusetts, Minnesota, Oregon, Colorado and New York. Ohio passed the law but it was declared unconstitutional, and, instead of attempting to modify it so as to comply with the constitution, it was repealed by the succeeding legislature.

A bill, copied from the New York law, was introduced in the last legislature of this state by Mr. Tingier of Vernon, but it was rejected.

This law, with various minor modifications, is substantially the same as that adopted by the other states, and is intended, first to make clear the title to the property in question; and, secondly, to provide an easy and ready means for the transfer of the title.

The law is permissive in that the owner is permitted to use the present system of transfer by title deeds or to use the new method; but, if he elects to act under the new law, all subsequent acts affecting the title to the property must be taken under the new system.

The machinery for carrying out the provisions of the law are the Superior Court, a registrar and, where necessary, a deputy registrar, both of whom must give bonds for the faithful performance of their duties, and an official examiner of titles, who must be a person or corporation approved by the Court as being qualified for the performance of the duties of the office.

Proceedings under the statute are to be made by filing a complaint and paying for the registration of the property with the registrar. The complaint must name as parties to the action all persons having or claiming to have any right or interest in or lien upon the property, or any part thereof, as shown by the examiner's certificate of title.

The examiner's certificate of title must accompany the complaint, and "shall set forth the exact state and condition of the title sought to be registered in the action; the name and post-office addresses, so far as known and reasonably ascertainable, and the rights and interests, or claimed rights and interests, of the plaintiff and all other persons having or claiming any rights or interests in or liens upon said property, or any part thereof, and the names and post-office addresses of the owners in fee simple of the surrounding contiguous properties, as far as they are known or can be reasonably ascertained by inquiry on said properties; and, as to actual or possible owners or claimants of the property sought to be registered, not known or not found it shall state fully what search and efforts have been made to find them."

As the surveyor's part in the proceedings is that which most interests us at the present time, we will quote the section relating to his part in the transaction:

"There shall be filed with the complaint and annexed thereto as an exhibit, and made a part thereof, the survey, map or plan of the land referred to in section eleven of this act, which shall be made by a competent surveyor approved by the court, and which shall clearly show the exact boundaries of the land and its connection with adjacent lands and any adjoining or neighboring streets and avenues, and all encroachments if any, and all other facts which are usually shown by accurate surveys. If any adjacent land is already registered, the survey so filed with the complaint must properly connect and harmonize with the survey of such previously registered land. There shall be attached to said survey, map or plan, and filed with it, an affidavit of the surveyor by whom it was made, that it was made by him personally or under his immediate supervision and direction; that it is a survey, map or plan of the property described in the certificate of title of the examiner, and that according to the best of his knowledge and belief said property is included in the boundaries shown on such survey, map or plan, without any encroachment or improper erections, except as follows (stating and describing any encroachments or improper location of buildings, fences or other structures.)"

This appears to "fill the bill" so far as description of the property is concerned, and would be a great advance on some descriptions which are frequently found in deeds, as may be illustrated by the description which the late Bill Nye once gave to some unsophisticated would-be investors in mining property, of the place where an alleged ore deposit was located in a western county: "It apparently cropped out a little Southeast of a point where the orbit of Venus bisects the milky way, and ran due East eighty chains, three links and a swivel, thence South fifteen paces and a half to a blue spot in the sky, thence proceeding West eighty chains, three links of sausage and a half to a fixed star, thence North across the lead to the place of beginning."

After a hearing and a finding of facts by a judge of the Superior Court, a decree is passed establishing the title to the property in question. The registrar then issues an original certificate of title, giving the name of the owner of the fee, and the name of all other parties who may have an interest in the property, and the character of their claims. A duplicate certificate is issued to the owner, and this, like a certificate of stock in a corporation, is his proof of ownership. For this certificate the owner gives a receipt to the registrar, which receipt must be in the handwriting of the person giving it. To further identify the owner of the property, the certificate not only states the name and post-office address but also whether such owner is married or unmarried, and if married, the name of the husband or wife. If the owner is a minor, it shall state the age; if under any other disability, it shall state the nature of such disability.

It would seem that nothing more would be necessary for identification unless it would be the attachment to the certificate of a colored photograph of the owner and a lock of his hair.

Up to the point of issuing an original certificate, the description—"a system of transfers by law suits attended to by lawyers"—is not inappropriate. For subsequent transactions, however, "system of land transfers by bookkeeping attended to by a clerk" is perfectly descriptive.

Each certificate is numbered serially and, when a transfer of title to the fee is made, the duplicate certificate is surrendered to the registrar and cancelled, and a new certificate is recorded and a duplicate is issued to the new owner. The new certificate refers back to the number of the original certificate and vice versa. All encumbrances, whether mortgage, lien, lis pendens or attachment, are endorsed on the certificate in the registrar's office; so that the original certificate shows, at all times, the exact condition of the property as regards ownership and encumbrances.

After the decree establishing the title is passed, a reasonable time is allowed for an appeal from the court's decision; after that time has expired, the title becomes absolute, and is guaranteed by the state.

The law of title by prescription, or adverse possession, is repealed so far as registered property is concerned.

To provide a fund whereby the state can insure the title, a fee is paid by the owner upon the issuance of the certificate. This varies in different states from one tenth to one quarter of one per cent. of the assessed value of the property.

Your committee is of the opinion that if any action is to be taken by the Society looking to a better description of property in title deeds, it had best be taken in connection with the securing, if possible, the passage of some such form of law as herein outlined.

A mandatory law requiring all deeds to have the property accurately described ought not, and probably could not, pass the legislature. For there is a large amount of land in this state, a survey of which, necessary for an accurate description, would cost more than the property was worth. If the law was permissive, then the present status would not be changed, and the statute books would be encumbered with one more useless law.

The "Torrens" system, however, introduces new and important elements; viz., a guarantee of title by the state; a means by which the exact status of a piece of property as regards title, encumbrances, etc., can be ascertained at a moment's notice; and offers the simplest possible means for effecting a transfer of title.

While a surveyor's description of a piece of property in a title deed would be a convenience in locating the property which it described, it would have no value whatever in fixing the legal boundaries; while in a registered certificate, the boundaries described therein are fixed and binding upon all parties in interest

While there is much to recommend the "Torrens" system, and there seems no good reason why it should not be adopted, such a law could not, probably, be passed in this state without a great effort on the part of those interested; for it would not only meet the opposition of all the conveyancers but also of all the town clerks, whose income would be materially lessened if such a law was in the statutes, and property owners availed themselves of its provisions to any great extent.

Respectfully submitted,

CHARLES A. FERRY.
A. J. PATTON

MR. FERRY: The committee purposely refrained from making any recommendation as to adoption of this system for the reason that where a committee makes a recommendation and they have no conviction about it one way or the other, it is merely putting the committee in the place of taking sides. This is a pretty important matter, and we felt that the Society ought to be left free to discuss the matter, and either drop it or boom it as they thought advisable. It is a question which has two sides. If there was but one side, there would be no reason for the appointment of a committee to look into it. There are good reasons for adopting it, and there are good reasons for not adopting it. The committee will leave it to the Society to bring out the reasons pro and con.

MR. A. B. HILL: I think, Mr. President, that about the best thing we can do is to have that printed and think it over for a year. It is a very important matter, and a matter which needs very careful consideration. The question of searching titles, and of the correct transfer of titles in real estate, is something that a great many people are interested in, and we ought not to adopt anything without very full consideration.

Mr. Bush: Mr. President, if this Society will make up their minds to some course of action it would have a great weight with the Legislature. We all agree that present conditions are not right, and there ought to be some change made so as to get a better description of land in deeds and mortgages. Probably there is not a member of the Society, that has been practicing his profession for five years, but what has been up against descriptions that attempted to describe property that did not in fact describe it. If we get up a petition to the General Assembly for a commission to consider this matter, it would have influence with them. Even if no permanent change was made, the discussion of the question, and the bringing of this matter to the attention of a large number of people, would be of the utmost benefit, and I think the agitation of it would result in some improvement, in better descriptions in future. Some time since, a Hartford lawyer brought five or six deeds, of what he supposed was adjacent property, to a certain engineer with the request that he plot them and search the title. Two or three of these deeds applied to property in an adjacent city block and had no reference to the plot in question; although the lawyer was sure by the descriptions that they all were adjoining. All the deeds covered land in the heart of the business section. Now that is the condition in Hartford, and I dare say a similar condition may be found in every town in the State of Connecticut. We, as engineers and surveyors, appreciate this more than people who have nothing to do with land records. The Society should take the lead in this, as the result would be beneficial to the Society, as well as to the state in general.

After further discussion it was voted that the matter be tabled for future consideration in this session.

The Committee on Testing Machines reported progress and was continued.

The Committee on Stream Measurements asked to be discharged.

Its request was granted.

The following were elected to membership: William J. Backes, Hartford; Roy C. Cram, New Haven; Charles C. Elwell, New Haven; Richard K. Green, Meriden; Benjamin R. Hawley, Stamford; Ralph D. Haven, Bristol; Charles L. Nord, Reynolds Bridge; Max Osgood, Pequabuck; Howard S. Porter, Hartford; John Sanders, New Haven; Robert W. Stevens, Saybrook; James Terry, Hartford; and Harrison R. Westcott, Bristol.

PRESIDENT'S ADDRESS.

Gentlemen, Members of Connecticut Society of Civil Engineers and Friends:

I bid you welcome to this the twenty-sixth annual meeting of our Society.

It now falls to me to give a brief statement of some matters pertaining to the welfare of the Society for the past year. Our membership has slightly increased, making a total membership of 297 as against a total membership of 286 in February last year. The finances of the Society have been carefully conserved by the Board of Direction and show improvement over the financial condition of last year. The financial condition of the Society would have been better had it not been necessary to draw on the funds of the Society to pay for the deficit of the summer meeting. At a meeting of the Board of Direction held last July it was voted to end the fiscal year on February 1, so that a definite time could be set for closing the accounts of the Society.

It is very desirable that the membership be increased each year as the life and prosperity of the Society depends upon its continual growth, and this can best be done by the united efforts of the members.

Two things are necessary to the success of an Engineering Society—a large, desirable membership, and dissemination of engineering matter through its proceedings. Surely our proceedings reflect great credit on the Society both as to substance and form, but we should not be content. A further effort should be made for its fullness and completeness regarding engineering work about the state. Members should overcome their bashfulness upon being invited to present papers, for the success of our annual meetings depends upon their coöperation in the presentation of such papers, thereby furnishing material for discussion and a permanent record of their work. It is only through the individual effort of its members that we may raise our standard and make our Society more felt in this community. Usually the annual address of the president of a Society is expected to give a review of engineering progress during the past year. I shall not attempt this, as I am sure you have no desire to praise your own achievements. The progress in the future should be greater than the past, benefiting by its experiences both by successful and unsuccessful efforts.

The number of Engineering Societies in the country is large and is increasing; and as long as the multiplication of such societies does not tend to weaken the strength of existing societies it is a benefit to the profession by the greater diffusion of engineering literature. There is, however, still a large opportunity for state societies representing state interests to make its influence more directly felt in connection with public improvements by a more public expression of opinion and a full and unbiased discussion of the proposed improvements. The state engineering societies are important aids in the education of the younger engineers, and also in the education of the public as to the needs for action for public benefit.

The state societies are in no way rivals or competitors of the national societies, on the contrary, they serve to a great extent as auxiliaries of the latter, and many young engineers join state societies and enjoy the privileges and benefits that would not join national societies. There is also a large element of personal interest and acquaintance at the meetings of state societies which is not possible in the national societies. In the same way the papers and discussions deal largely with matters of local interest and practice within the state.

There is a subject that I would suggest that the Society consider,—that is in regard to the establishment of a Society library. The important matter in this connection is for the Society to have permanent quarters; as at present the Society has no place where books and records can be kept, and therefore no effort has been made for the preserving of any engineering matter which might have accumulated in past years. And it is doubtful if the Society is in possession of a complete set of its own proceedings. Surely this is a matter of great interest and concern, and it is to be hoped that some provision can be made so that a library can be started, thereby preserving present matter and furnishing an incentive to the members and friends of the Society for the presentation of books, pictures and relics of engineering work.

The summer meeting of the Society was held at Stony Creek in August last, attended by about 30 members and guests; the new trolley viaduct of The Connecticut Company extending between Chapel and Water Streets, New Haven, was inspected, together with the neighboring stone quarries at Stony Creek, but the day was unpropitious for close inspection on account of rain. The seclusion of the Indian Point Hotel was in order, however. A very enjoyable trip was made through the Thimble Islands in the afternoon and the day ended with a very satisfactory dinner at the hotel.

In closing I wish to thank the other officers as well as the members of the Society for their cordial coöperation and support during the year.

Report of the Tellers.

Total number of ballots, 80.

For President: Whole number of votes cast, 80. Necessary for a choice 41, of which Shepard B. Palmer has 79, scattering 1.

For Vice-President: Whole number of votes cast, 80. Necessary for a choice, 41, of which Charles A. Ferry has 80, a unanimous election.

For Second Vice-President: Whole number of votes cast, 75. Necessary for a choice, 38, of which A. William Sperry has 65, scattering 10.

For Secretary-Treasurer: Whole number of votes cast, 79. Necessary for a choice, 40, of which J. Frederick Jackson has 79, a unanimous election.

For First Director: Whole number of votes cast, 73. Necessary for a choice 32, of which George J. Crandall has 72, scattering 1.

For Second Director: Whole number of votes cast, 76. Necessary for a choice, 39, of which John K. Punderford has 75, scattering 1.

President Easterbrook then introduced President-elect Palmer, who said:

Mr. President and Gentlemen: I wish, of course, to thank you for electing me president. I realize that it is no small honor to be the president of a Society which now numbers over three hundred members. I also realize how little training I have had for this office, having been on the Board of Direction for only one year. For that reason, I shall ask your counsel and advice, notwithstanding the tenor of an address I read at one time on "Independence." It was something like this: "that as to advice, none are so foolish as the ones who give it, except the ones who take it." I shall appreciate all the advice which you may give me, and I will equally appreciate your coöperation. I believe that is what we want. With your cooperation and the Society's support, with our able Board of Direction, I feel sure that the next year will be one of progress.

Meeting adjourned to 1.30 P. M., when the members assembled at the Hammond Laboratory and listened to Prof. Huntoon's paper, which is printed on page 40.

At the conclusion of Prof. Huntoon's address the members made a trip through the various departments of the building, and at its conclusion returned to North Sheffield Hall for the balance of the afternoon session.

Convention re-convened at North Sheffield Hall, President Easterbrook in the chair.

THE PRESIDENT: I think there is no business for us to take up before proceeding with our programme. The first paper on the list this afternoon is "The Sea Wall in Connection with Power Stations and Manufacturing Buildings," by Mr. George A. Orrok. I take pleasure in introducing Mr. Orrok to you. Mr. Orrok's paper is printed on page 97.

Prof. Gregory then read his paper on The Water Resources of the Navajo Reservation. Paper printed on page 112.

Meeting adjourned until 9 A. M. Wednesday.

SECOND DAY—MORNING SESSION.

Convention called to order at 9:30 A. M., President Easterbrook in the chair.

THE PRESIDENT: We will come to order and hear the report on the Society pin, the result of the vote taken at the banquet last night.

MR. BLAIR: There were sixty-three votes cast. Those voting for a pin fifty-one, and those voting against a pin were three. The indifferent ones were ten. For the No. 1 design there were twenty-five; for the No. 2, twelve and one-half; and No. 4 design, twenty-three and one half.

After considerable discussion it was voted that the matter of the pin be referred back to the committee with instructions to report at the next summer meeting.

Mr. Hinckley not being able to be present, his paper, "Problems Handled by the Test Department of a Large Corporation," was read by Secretary Jackson. Paper printed on page 25

Mr. Ford then read his paper on "Eight Weeks Civic Study Abroad." Paper printed on page 1.

Mr. Welton being absent, his paper was explained by Mr. Chandler, who also read a short introduction to this paper They are printed on pages 65 to 71

Mr. Chandler then read his paper on "Dams Approved by Henry T. Potter." Paper printed on page 72

The report of the committee on better descriptions of land in deeds of transfer was taken from the table and after further discussion it was voted that the report be printed in the annual proceedings, the committee to be continued and report at our next meeting.

Votes of thanks were extended to the officers of the Sheffield Scientific School, to the gentlemen who contributed papers to the meeting and to the local committee on arrangements.

Meeting adjourned 1.15 P. M.

CONSTITUTION.

ARTICLE I.

NAME AND OBJECT.

SECTION 1.—The name of this Society shall be the CONNECTICUT SOCIETY OF CIVIL ENGINEERS.

OBJECT.

SEC. 2.—The object of this Society shall be the professional improvement of its members; the encouragement of social intercourse among men of practical science, and the advancement of engineering in its several branches, to wit: Civil, hydraulic, naval, sanitary, mechanical, electrical, architectural, mining, geological, metallurgical, and chemical; the reading and discussion of papers, or to hear lectures on any of the above topics relating to engineering science, and the transaction of all business properly belonging to said Society.

ARTICLE II.

MEMBERSHIP.

SECTION 1.—The membership of this Society shall consist of Members, Honorary Members and Associate Members.

MEMBERS.

SEC. 2.—Members must be at least twenty-one years of age and have had two years' actual experience in some branch of engineering or surveying, or shall have been graduated from an engineering course in a college or university of recognized standing, and they only shall be entitled to vote or transact business for the Society.

HONORARY MEMBERS.

SEC. 3.—Honorary Members may be as many as the Society shall elect. They shall have no vote, nor shall they be eligible to hold office. They shall have the right to attend all public meetings and to enjoy such other privileges as the Society may see fit to grant, excepting, however, such Honorary Members as may be elected from *active membership*, when they shall retain their right to vote and to hold office.

ASSOCIATE MEMBERS.

SEC. 4.—Any person desiring to become associated with this Society, who is not eligible to active membership, may make application, and if said application receives a favorable report from the Board of Direction, it shall be acted upon by the Society at the next regular meeting, and if said candidate shall receive a majority of the votes cast he shall be declared elected as an Associate Member. Associate Members shall have no vote, nor shall they be eligible for any office.

ARTICLE III.

OFFICERS AND THEIR DUTIES.

OFFICERS.

SECTION 1.—The officers of this Society shall be, a President, two Vice Presidents, a Secretary and Treasurer, an Assistant Secretary, and four Directors.

ELECTION OF OFFICERS.

SEC. 2.—The officers, excepting the Assistant Secretary, shall be elected at the annual meeting, and shall hold their respective offices until the final adjournment of the meeting in which others are elected and qualified in their places.

PRESIDENT.

SEC. 3.—The President shall preside at all meetings when present. He shall be chairman of the Board of Direction, and of all standing committees, and shall appoint all special committees, unless otherwise ordered by a vote of the Society.

VICE PRESIDENTS.

SEC. 4.—In the absence or inability of the President to act, the Senior Vice President present shall perform his duties.

SECRETARY.

SEC. 5.—The Secretary shall attend all meetings of the Society, and the Board of Direction, and shall keep the minutes thereof. He shall conduct the general correspondence of the Society, receive communications addressed thereto, and present the same to the proper committees, officers, or meetings. He shall issue notices of all meetings, inform committees of their appointment, and officers and new members of their election. He shall notify all committees of coming meetings and prepare the matters for presentation. He shall keep a complete list of all members, with their addresses and dates of election. He shall publish the annual report. He shall perform such other duties pertaining to his office as may be imposed upon him by the Society or by the Board of Direction, and shall receive a salary to be fixed by the Society.

TREASURER.

SEC. 6.—The Treasurer shall keep the accounts, collect all the funds of the Society and shall deposit the same to the credit of the Society in such depositories as may be designated by the Board of Direction. He shall pay all bills, when approved by the President or a majority of the Board of Direction. He shall keep book accounts of his receipts and expenditures, which shall at all times be open to the inspection of the Board. He shall make a duly audited itemized report to the annual meeting. He shall give bonds for the faithful performance of his duties, in such amounts and with such sureties as the Board of Direction may require, and he shall receive such remuneration as the Society may vote to him from time to time. The Board of Direction shall audit the Treasurer's accounts and books annually.

ASSISTANT SECRETARY.

SEC. 7.—The Assistant Secretary shall be appointed annually by the President, and his duties shall be such as would pertain to the office of executive secretary.

BOARD OF DIRECTION.

SEC. 8.—This Board shall consist of the President, the two Vice Presidents, and the four Directors. It shall have supervision and care of all the affairs and property of the Society, and shall conduct the same in accordance with the Constitution and By-Laws. The President or one of the Vice Presidents shall preside at all meetings of the Board, in the order of seniority. In the absence of all these officers, a chairman *pro tem.* may be appointed for the meeting. The first year after this section is adopted, four members shall be chosen at the annual meeting, two shall be chosen for a term of one year and two to serve two years. At all subsequent annual meetings two members shall be chosen to serve two years. Four members shall constitute a quorum to transact business.

ARTICLE IV.

ELECTIONS.

OFFICERS, WHEN ELECTED.

SECTION 1.—At each annual meeting the Society shall elect by ballot, a President, two Vice Presidents, and a Secretary and Treasurer, to serve one year; also two Directors to serve two years.

NOMINATIONS, HOW MADE.

SEC. 2.—A nominating blank, containing a list of officers to be voted for, shall be sent by the Secretary to each member, at least sixty (60) days before the day of the annual meeting. The nominations for officers shall be returned to the Secretary in an envelope endorsed with the member's signature, within twenty-one (21) days from the date upon which the blanks were mailed to members, and shall be delivered by him, unopened, to the Board of Direction at a meeting to be held by them to canvass such nominations.

A member nominated for an office by as many as ten (10) other members may become a candidate for that office. If a member be nominated for more than one office, he shall be considered as having been nominated for that office for which he received the most nominating ballots.

If no member receives ten (10) nominating ballots for an office, or if for any reason there should be no candidate for an office, the Board of Direction shall nominate at least two candidates for that office.

All nominees for office shall be notified at once by the Secretary of their nomination and, unless the Secretary receives a prompt declination, it shall be assumed that they have accepted such nomination.

ELECTIONS, HOW CONDUCTED.

SEC. 3.—At least twenty-one (21) days before the annual meeting the Secretary shall send each member a ballot, containing the names (arranged alphabetically) of the candidates for each office. This shall be accompanied by an envelope addressed to the Secretary, with a blank space on the back for the signature of the member voting, also a blank envelope carrying no mark for recognition.

Each member shall signify his choice of candidates on the ballot and return it to the Secretary in two sealed envelopes; the inner one to be left entirely blank, and the outer one endorsed with signature of sender.

Ballots may be sent by mail to the Secretary or handed to him directly. The Secretary shall deliver the ballots, unopened, to the tellers appointed by the presiding officer.

The polls will close at eleven o'clock in the morning of the day of the regular annual business meeting of the Society.

MEMBERS IN ARREARS CANNOT VOTE.

SEC. 4.—It shall be the duty of the Treasurer to furnish the tellers with an alphabetical list of members in arrears for dues for two years or more, and no vote from a member so in arrears shall be counted. Ballots received from such members shall be returned to them unopened with a statement of the reason for such action.

PLURALITY ELECTS.

SEC. 5.—The candidate for each office receiving a plurality of the votes shall be declared elected. In case of a tie vote, the meeting shall proceed to vote by ballot for the candidates who are tied.

NOTIFICATION.

SEC. 6.—The Secretary shall officially notify in writing each officer of his election.

Officers so elected shall qualify and assume their duties immediately after the adjournment of the meeting at which they are elected, and shall hold office until their successors are duly elected and qualified.

VACANCIES.

SEC. 7.—Vacancies occurring for any cause in the list of officers shall be filled by the Board of Direction.

ELECTION OF MEMBERS.

SEC. 8.—Each application shall be announced on the notices for the next meeting after it is received, shall then be considered by the Board of Direction, and, if approved, shall be presented to the Society for ballot at a regular meeting. If a candidate receives a majority of the ballots, he shall be declared elected. In case of rejection, no minute shall be published, but the Secretary shall notify the applicant by letter.

APPLICATION FOR MEMBERSHIP.

SEC. 9.—All applications for membership or for transfer from one grade of membership to another, shall be made on a regular form, to be secured from the Secretary, and to be endorsed by three Members. This form shall contain, immediately over the signature of the applicant, a clause in which the applicant shall agree that if elected he will be governed in all Society matters by the Constitution and By-Laws, and will forward the interest of the Society at all times.

ARTICLE V.

MEETINGS.

ANNUAL MEETING.

SECTION 1.—There shall be a *regular annual meeting* held on the second Tuesday of February each year, at such place as may be selected by the Board of Direction, of which due notice shall be given by the Secretary.

MEETINGS, HOW CALLED.

SEC. 2.—Special meetings may be called by the President and, when so called, notice of the meeting specifying the business thereof shall be mailed by the Secretary to the postoffice address of each member at least ten days before such meeting shall be held. Special meetings shall be called by the President on written application of any ten (10) members.

QUORUM.

SEC. 3.—Ten per cent. of the membership shall constitute a quorum for the transaction of ordinary business, except for the election of officers or for voting on amendments to the Constitution or By-Laws, which shall require fifteen per cent.

ARTICLE VI.

DUES.

SECTION 1.—The annual dues of Members and Associate Members shall be three ($3.00) dollars per year, payable in advance at the annual meeting.

Members elected at any time of the year shall pay full dues for that year.

SEC. 2.—Honorary Members shall pay no annual dues.

SEC. 3.—The Board of Direction shall have power to remit dues when, in their opinion, it is for the best interest of the Society.

ARTICLE VII.

DEPRIVATION OF MEMBERSHIP.

SECTION 1.—Any member whose dues shall remain unpaid for two (2) years shall be notified by the Treasurer, by sending by registered mail a bill for dues in arrears, on the face of which bill shall be printed the sections of the Constitution covering such cases. If the dues are not paid within thirty (30) days after such notification, the matter shall be presented to the Board of Direction, who shall have power to drop such member from the roll.

RESIGNATIONS.

SEC. 2.—Resignations must be submitted in writing to the Secretary, and may be accepted by the Board of Direction when all indebtedness to the Society has been discharged.

SEC. 3.—All charges against any member shall be investigated by the Board of Direction before being submitted to the Society.

Any member may be expelled for conduct which may be deemed prejudicial to the Society, by a two-thirds vote of the Members present at a business meeting; provided, that not less than fifteen (15) vote for expulsion, and that such member shall have had one month's notice of the charges preferred against him and of the time appointed for their consideration. All charges must fully set forth the offense or offenses alleged, and must be signed by the members preferring them. An attested copy must be furnished the accused, who shall be entitled to be present and to be heard in defense, in person or by attorney, at all meetings at which the charges are investigated, except during the time when a final vote is being taken.

ARTICLE VIII.

AMENDMENTS TO THE CONSTITUTION.

SECTION 1.—Proposed amendments to this Constitution must be presented in writing at a regular business meeting of the Society, and signed by at least three Members.

Amendments so presented shall be read at the meeting and a copy filed with the Secretary at the same time. At the meeting when presented the proposed amendments may be discussed and amended, but cannot be adopted.

SEC. 2.—At any regular business meeting the amendments previously presented, according to Section 1, may be voted upon by letter ballot. These ballots shall be sent out with the call for the meeting and shall have the proposed amendment, together with the section of the present Constitution covering the point in question, printed upon the ballot. With the ballot shall also be sent an envelope directed to the Secretary and marked "Ballot on Amendment." The Secretary shall keep these letters unopened and present to the presiding officer all replies received up to the hour of closing the polls. Tellers shall be appointed by the presiding officer, who shall open and count all ballots. The result shall be announced at the meeting by the presiding officer. Two-thirds of the ballots cast will be necessary for the adoption of an amendment.

Sec. 3.—The Board of Direction is authorized to number the Articles and Sections of the Constitution and By-Laws to correspond with any changes that may be made.

BY-LAWS.

MEETINGS.

1. In addition to the regular annual meeting, as provided by the Constitution, the Society shall hold at least one other general meeting, and may hold such other meetings to listen to lectures or addresses, or to visit engineering works of interest, or of a purely social nature, as the Board of Direction may decide to call.

GENERAL ORDER OF BUSINESS AT ANNUAL MEETING.

2. The following general order of business shall be observed at annual meetings:

1. Presentation of, and action upon, minutes of last meeting.
2. Report of Board of Direction.
3. Report of Secretary.
4. Report of Treasurer.
5. Report of any Special Committees.
6. Election of new members.
7. Election of officers.
8. Address of President.
9. Miscellaneous business.
10. Papers, lectures, or addresses.
11. Adjournment.

BUSINESS MEETINGS—ORDER.

3. The following general order shall be observed at Business Meetings:

1. Presentation of, and action upon, minutes of last meeting.
2. Miscellaneous announcements.
3. Stated business.
4. Adjournment.

4. Contributing Members under the old Constitution shall become Associate Members upon the adoption of the Revised Constitution.

5. Actual personal transportation expenses incurred by the Secretary in attending meetings shall be paid from the Society treasury, upon approval of the President or two members of the Board of Direction.

6. In the election of Honorary Members, a unanimous vote is necessary to elect.

7. The Society may at any time, duly named for the purpose, enact By-Laws for the future guidance, consonant with the Constitution. These By-Laws may be amended or repealed at any meeting, in the call for which meeting a copy of the proposed amendment or addition shall have been printed and sent to each member with the said notice.

PARLIAMENTARY RULES.

8. In all questions arising at any meeting, involving parliamentary rules, not provided for in these By-Laws, Roberts' Rules of Order shall be the governing authority.

VISITORS.

9. Visitors may be admitted to meetings under such rules as the meeting may prescribe.

10. All forms, such as blanks for application for membership, ballots for officers, ballots on amendments to Constitution or By-Laws, and other necessary blanks for the conduct of the business of the Society, shall be prepared by the Secretary and approved by the Board of Direction.

CHARTER MEMBERS OF THE SOCIETY.

HONORARY

Prof. John E. Clark	April, 1884
George H. Frost	April, 1884

ACTIVE

E. P. Augur	April, 1884
H. W. Ayres	Jan. 13, 1885
G. H. Bishop	Jan. 13, 1885
D. S. Brinsmade	April, 1884
C. H. Bunce	April, 1884
L. W. Burt	Jan. 13, 1885
C. E. Chandler	April, 1884
R. S. Hulbert	April, 1884
C. M. Jarvis	April, 1884
H. J. Kellogg	April, 1884
F. W. Laforge	Jan. 13, 1885
J. M. McKenzie	April, 1884
W. B. Palmer	Jan. 13, 1885
S. C. Pierson	Jan. 13, 1885
A. W. Rice	April, 1884
William G. Smith	April, 1884
Nelson J. Welton	April, 1884
J. K. Wilkes	April, 1884

List of Members.

With Addresses and Dates of Election.

Members are particularly requested to inform the Secretary at once of any change in address.

HONORARY MEMBERS.

CHITTENDEN, PROF. RUSSELL H. ....April 20, 1901
Dean of Sheffield Scientific School of Yale University, New Haven, Conn.

CLARK, JOHN E. ....April, 1884
Prof. Mathematics, Emeritus, at Sheffield Scientific School, Yale University, Springfield, Mass.

FITZGERALD, DESMOND ....Jan. 8, 1901
Consulting Engineer, Brookline, Mass.

FROST, GEORGE H. ....April, 1884
President Engineering News Publishing Co., New York.

FULLER, WILLIAM B. ....Feb. 12, 1908
Consulting Engineer, 170 Broadway, New York.

HADLEY, DR. ARTHUR T. ....April 20, 1901
President Yale University, New Haven, Conn.

HAUPT, LEWIS ....Feb. 12, 1907
Consulting Engineer, Bellmar, N. J.

HAYNES, EDWARD C. ....Jan. 14, 1890
Rodman, N. Y.

PETTEE, WILLIAM E. ....Jan. 10, 1899
Civil Engineer, Salisbury, Conn.

SEYMOUR, WILLIAM O. ....Feb. 9, 1904
Railroad Commissioner, Ridgefield, Conn.

SKINNER, FRANK W. ....Jan. 9, 1900
Editorial Staff of the Engineering Record, New York.

SCOFIELD, HORACE G. ....Feb. 14, 1906
Civil Engineer, Bridgeport, Conn.

MEMBERS.

ALDERSON, ALGERNON E. ....Jan. 10, 1899
Town Engineer, West Hartford, Conn.

ALLEN, GEORGE B. ....Aug. 12, 1908
Civil Engineer, Hartford, Conn.

AMRHYN, GUSTAVE X., Associate Member ....Feb. 9, 1904
Department of Parks, New Haven, Conn.

AUGUR, EDWIN P. ....April, 1884
Civil Engineer and Surveyor, and City Surveyor, Middletown, Conn.

AYRES, HENRY W. .... Jan. 13, 1885
Hydraulic Engineer, Hartford, Conn.

AZHDERIAN, REUBEN B. .... Feb. 12, 1907
Assistant City Engineer, Bridgeport, Conn.

BACKES, WILLIAM J. .... Aug. 17, 1909
Civil Engineer, Hartford, Conn.

BACON, ARTHUR W. .... Feb. 9, 1904
Hall & Bacon, Civil Engineers, New Britain, Conn.

BANTA, D. SCHUYLER .... Aug. 23, 1905
Civil Engineer, Hartford, Conn.

BARKER, WILLIAM H. .... Aug. 10, 1904
Expert in Patent Causes, 160 Broadway, New York.

BARNEY, SAMUEL E. .... Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

BARTLETT, FRANK .... Aug. 17, 1909
Civil Engineer, Torrington, Conn.

BEACH, CHARLES EDWARD .... Jan. 10, 1893
Civil Engineer, West Hartford, Conn.

BEARDSLEY, ROBERT .... Aug. 17, 1909
Civil Engineer, Naugatuck, Conn.

BELDEN, EDGAR T. .... Jan. 8, 1901
Box 931, Pittsfield, Mass.

BENNETT, CHAS. J. .... Aug. 14, 1906
Engineering Department, N. Y., N. H. & H. R. R. Co., Hartford, Conn.

BENNETT, RAYMOND F. .... March 30, 1900
Bennett's Contracting Corporation, Portland, Maine.

BLACK, WILLIS J. .... Feb. 13, 1906
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

BLAIR, CLARENCE M. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

BLAKESLEE, CLARENCE .... Jan. 9, 1900
Civil Engineer and Contractor, New Haven, Conn.

BLATCHLEY, WILLIAM J. .... Aug. 10, 1904
Civil Engineer, New Haven, Conn.

BLEIM, DANIEL WILLIAM .... Feb. 12, 1907
Manager American Bridge Co., East Berlin, Conn.

BODFISH, HENRY L. .... Feb. 13, 1906
Civil Engineer, N. Y., N. H. & H. R. R. Co., Waterbury, Conn.

BRADLEY, DANIEL E. .... Jan. 9, 1894
President Berlin Construction Co., Berlin, Conn.

BRAINARD, ALBERT S. .... Aug. 12, 1908
Civil Engineer, East Hartford, Conn.

BRETT, THOMAS C. .... Aug. 10, 1904
Secretary Yale Safe & Iron Works, New Haven, Conn.

BREWER, WILLARD SEYMOUR .... Feb. 12, 1907
City Engineer's Office, Hartford, Conn.

BRINSMADE, DANIEL E. .... April 20, 1901
Secretary and Assistant Engineer Ousatonic Water Co., Shelton, Conn.

BRINSMADE, D. S. .... April, 1884
Engineer Housatonic Water Power Co., Derby, Conn.

BRISTOL, WARREN P. .... Aug. 12, 1908
Associate Member, Hartford, Conn.

BROWN, CHARLES B. .... Aug. 14, 1907
Prof. of Railroad Engineering, University of Maine, Orono, Maine.

BROWN, CHARLES O. .... Jan. 11, 1898
City Engineer, Danbury, Conn.

BROWN, EDMUND .... Jan. 10, 1899
Superintendent and Engineer of Norfolk Water Co., Norfolk, Conn.

BROWN, WALTER A. .... Feb. 13, 1906
Engineering Dep't, N. Y., N. H. & H. R. R., Waterbury, Conn.

BUCK, HENRY R. .... Jan. 10, 18[illegible]
Civil Engineer, Hartford, Conn.

BUNCE, CHARLES H. .... April, 1884
Civil Engineer, Hartford, Conn.

BURGHARDT, WALLACE .... Feb. 13, 1906
Town Engineer, North Canaan, Conn.

BURT, LUTHER HAROLD .... Aug. 14, 1900
Assistant Engineer, Bronx Valley Sewer Commission, White Plains, N. Y.

BURT, LUTHER W. .... Jan. 13, 1885
Civil Engineer and Surveyor, Hartford, Conn.

BUSCHOR, EMIL CHARLES .... Jan. 10, 1899
Civil Engineer and Surveyor, Arlington, N. J.

BUSH, EDWARD W. .... Jan. 10, 1899
Chief Engineer, Conn. River Bridge, Saybrook, Conn.

BUSHNELL, W. G., Associate Member .... Feb. 14, 190[illegible]
Electrical Engineer, New Haven, Conn.

CADWELL, WILLIAM H. .... May 31, 1893
Civil Engineer, New Britain, Conn.

CAHN, ALEXANDER .... Jan. 9, 19[illegible]
Civil Engineer, New Haven, Conn.

CAIRNS, ROBERT A. .... Aug. 20, 18[illegible]
Sanitary and Hydraulic Engineer and City Engineer, Waterbury, Conn.

CAMPBELL, CARROL A. .... Feb. 9, 1909
Civil Engineer, West Hartford, Conn.

CANFIELD, ANDREW G. .... Feb. 9, 1909
Civil Engineer, Bridgeport, Conn.

CARLISLE, HARRY E. .... Jan. 9, 19[illegible]
Central Engineer, S. N. E. Telephone Co., New Haven, Conn.

CAUM, FRANK .... Aug. 14, 19[illegible]
General Manager Scranton Railway Co., Scranton, Pa.

CHANDLER, CHARLES E. .... April, 1884
Civil Engineer, Norwich, Conn.

CHAPMAN, FREDERICK S. .... Feb. 10, 1903
Civil Engineer, Philippine Islands.

CHASE, CHARLES F. .... March 30, 19[illegible]
Engineer Berlin Construction Co., New Britain, Conn.

CHENEY, RICHARD OTIS, JR. .... Jan. 9, 1900
Civil Engineer, South Manchester, Conn.

CHILD, JONATHAN H. .... Feb. 11, 1908
Civil Engineer, Woonsocket, R. I.

CLARK, HERBERT G. .... July 18, 1899
Engineer of Keney Park, Hartford, Conn.

CLARK, ROSCOE N. .... July 18, 1899
Assistant City Engineer, Hartford, Conn.

CLARK, VINCENT B.	Feb. 9, 1904	City Engineer, Ansonia, Conn.
CLARK, WILLIAM S.	July 14, 1890	Civil Engineer, Meriden, Conn.
COE, ROBERT J.	Aug. 12, 1908	Civil Engineer, Waterbury, Conn.
COE, THEODORE I.	Jan. 9, 1900	Architect, 100 William St., New York.
COGGESHALL, R. C. P.	June, 1887	Superintendent of Water Works, New Bedford, Mass.
COLE, CLINTON L.	Feb. 9, 1904	Civil Engineer, Conn. River Bridge and Highway District, Hartford, Conn.
COLE, REMSEN B., JR.	Feb. 9, 1909	Civil Engineer, Waterbury, Conn.
COLLINS, HARRY C.	July 18, 1899	Berlin Construction Co., Boston, Mass.
COMSTOCK, LEWIS B.	Aug. 10, 1904	Civil Engineer, New Rochelle, N. Y.
CONE, JOSEPH W.	Aug. 12, 1908	Civil Engineer, Greenwich, Conn.
CORSON, WILLIAM R. C.	Feb. 10, 1903	Electrical Engineer, Hartford, Conn.
CRAM, ROY C.	Feb. 8, 1910	Civil Engineer, New Haven, Conn.
CRANDALL, GEORGE K.	Jan. 11, 1887	City Engineer, New London, Conn.
CRAWFORD, CHARLES M.	July 18, 1899	Civil Engineer, New Haven, Conn.
CRAWFORD, NORMAN McDONALD	July 18, 1899	Consulting Engineer, Youngstown, Ohio.
CURTIS, CHARLES D.	Aug. 17, 1909	Civil Engineer, Naugatuck, Conn.
CURTIS, FAYETTE S.	Jan. 9, 1900	Vice President N. Y., N. H. & H. R. R., Boston, Mass.
CURTIS, GEORGE H.	Aug. 17, 1909	Civil Engineer, Waterbury, Conn.
CURTISS, GREY WILLIS	Feb. 12, 1907	Civil Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.
DABOLL, LOREN E.	Jan. 8, 1895	Civil Engineer, New London, Conn.
DARROW, COURTLAND R.	Jan. 8, 1895	Civil Engineer, Waterford, Conn.
DAVIS, ARTHUR L.	July 18, 1899	Assistant to President, American Bridge Co., 30 Church St., New York.
DAWLEY, EDWIN P.	Aug. 14, 1906	Consulting Engineer, 532 Banigan Bldg., Providence, R. I.
DENMAN, MATTHIAS W.	Feb. 11, 1908	Civil Engineer, Springfield, Mass.
DePEYSTER, FREDERICK	Sept. 3, 1891	General Manager Brainard, Schaler & Hall Quarry, Portland, Conn.
DEYO, SOLOMON LeF.	Jan. 9, 1900	Chief Engineer New York Rapid Transit Subway Construction Co., New York City, N. Y.

DuBOIS, AUGUSTUS J. ....Jan. 9, 1900
Prof. Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

DUNCAN, EDGAR T. ....Feb. 14, 1905
Civil Engineer, Hartford, Conn.

DUNHAM, WILLIAM ROBERT, JR. ....Feb. 12, 1907
Civil Engineer Consolidated Railway Co., New Haven, Conn.

EASTERBROOK, FREDERICK J. ....March [illegible]
Chief Engineer, O'Brien Construction Co., New York City.

EDDY, CHARLES W. ....Jan. 9, 19[illegible]
Assistant Engineer, Waterbury Water Supply, Thomaston, Conn.

ELLSWORTH, FREDERICK H. ....March [illegible], 19[illegible]
Division Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

ELWELL, CHARLES E. ....Feb. 8, [illegible]
Engineer of Connecticut Co., New Haven, Conn.

EVERIT, EDW. H. ....Oct. 11, 19[illegible]
Engineer S. N. E. Telephone Co., New Haven, Conn.

FARNHAM, CHARLES S. ....Feb. 9, 1904
Instructor Civil Engineering Sheffield Scientific School, Yale University,
New Haven, Conn.

FERRY, CHARLES A. ....Jan. 9, 1906
Civil Engineer and Surveyor, New Haven, Conn.

FORD, FREDERICK L. ....Jan. 12, 1897
City Engineer, Hartford, Conn.

FORD, THEODORE B. ....April 20, 1901
Civil Engineer, Bridgeport, Conn.

FULTON, WILL H. ....Jan. 8, 1901
City Engineer's Office, New Haven, Conn.

GAGEL, EDWARD ....Jan. 9, 1900
Chief Engineer N. Y., N. H. & H. R. R. Co., New Haven, Conn.

GIBBS, NATHAN J. ....Feb. 9, 1909
Civil Engineer, Norwich, Conn.

GILLETTE, GEORGE W. F. ....Jan. 9, 1900
Gillette Construction Co., Malley Bldg., New Haven, Conn.

GLADDING, HENRY H. ....Jan. 9, 1900
Assistant City Engineer, New Haven, Conn.

GOSS, EDWARD O. ....Nov. 20, 189[illegible]
Assistant Treasurer Scovil Mfg. Co., Waterbury, Conn.

GRAVES, EDWIN D. ....Oct. 25, 1895
Chief Engineer Conn. River Bridge and Highway District, Hartford, Conn.

GREEN, RICHARD H. ....Feb. 8, 1911
Civil Engineer, Meriden, Conn.

GREENWOOD, ALBERT H. ....Feb. 9, 1904
With Berlin Construction Co., Berlin, Conn.

GREGORY, J. LOUIS ....Aug. 10, 1911
Civil Engineer, Larchmont, N. Y.

HALL, PERCY L. W. ....Feb. 10, 1903
Superintendent Middletown Water Works, Middletown, Conn.

HALL, A. CLARK ....Jan. 8, 1901
Hartford Water Department, West Hartford, Conn.

HALL, CHARLES [illegible] ....Feb. 12, 1907
Civil Engineer, Consolidated Railway Co., New Haven, Conn.

HALL, WILLIAM HENRY ....Feb. 12, 1907
[illegible], New Britain, Conn.

HAM, GEORGE .... Aug. 17, 1909
Civil Engineer, Naugatuck, Conn.

HAND, GEORGE F. .... Feb. 13, 1906
Civil Engineer, West Haven, Conn.

HANS, ALEXANDER JOSEPH .... Feb. 12, 1907
Civil Engineer, Locust Valley, L. I.

HARRISON, IRVING WARREN .... Feb. 12, 1907
City Engineer's Office, Waterbury, Conn.

HARTE, CHARLES R. .... Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

HASTINGS, F. B., Associate Member .... Feb. 10, 1903
B. D. Pierce Co., Bridgeport, Conn.

HATCH, CHARLES .... Feb. 13, 1906
Civil Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

HAVEN, RALPH D. .... Feb. 8, 1910
Civil Engineer, Bristol, Conn.

HAWLEY, ARTHUR S. .... Feb. 11, 1902
C. W. Blakeslee & Sons, New Haven, Conn.

HAWLEY, BENJAMIN R. .... Feb. 8, 1910
Civil Engineer, Stamford, Conn.

HENDERSON, JOHN T. .... July 18, 1899
Assistant Engineer Conn. River Bridge and Highway District, Hartford, Conn.

HICKEY, WILLIAM F., Associate Member .... Feb. 9, 1909
Care of Carnegie Steel Co., Boston, Mass.

HILL, ALBERT B. .... Jan. 9, 1900
Civil and Consulting Engineer, New Haven, Conn.

HINE, FRANK E. .... April 20, 1901
Civil Engineer, Fisher's Island, N. Y.

HOSLEY, ROBERT M. .... Aug. 23, 1905
Civil Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

HOYT, SAMUEL N., JR. .... Feb. 9, 1904
Civil Engineer, South Norwalk, Conn.

HUBBARD, CHARLES E. .... Aug. 19, 1909
Civil Engineer, Hartford, Conn.

HULBERT, ROBERT S. .... April, 1884
Civil Engineer, Winsted, Conn.

HULBERT, TIMOTHY ANDREWS .... Feb. 12, 1907
Technical Editor, Good Roads Magazine, New York, N. Y.

HUNTER, FRED C. .... Aug. 12, 1908
Resident Engineer, C. N. E. Ry., Poughkeepsie, N. Y.

JACKSON, J. FREDERICK .... Jan. 9, 1900
Civil Engineer, New Haven, Conn.

JAMESON, MINOR S. .... Feb. 9, 1904
Assistant Engineer, N. Y., N. H. & H. R. R. Co., New Rochelle, N. Y.

JARVIS, CHARLES M. .... April, 1884
Vice President P. & F. Corbin Co., New Britain, Conn.

JAYNES, FRANK B. .... Feb. 10, 1903
Civil Engineer, Bridgeport, Conn.

JESSUP, JOHN C., JR. .... Feb. 9, 1904
Superintendent Foundation Co., Rochester, N. Y.

JOHNSON, GEORGE R. .... Aug. 14, 1906
Civil Engineer, West Haven, Conn.

JOHNSON, WILLIAM D. .... Aug. 14, 1900
Architect, Hartford, Conn.

JOHNSON, WILLIAM E. ....Nov. 29, 1890
Engineer of Hartford Water Works, West Hartford, Conn.

JONES, WALTER A. ....Feb. 10, 1903
Civil Engineer, New Haven, Conn.

KEENEY, ERNEST A. ....Feb. 14, 1905
Civil Engineer Conn. River Bridge and Highway District, Hartford, Conn.

KEHR, HARRY T. ....Aug. 10, 1904
Civil Engineer, 330 W. 4th St., New York, N. Y.

KEITH, HERBERT C. ....Jan. 9, 1900
Consulting Engineer, 1213 Morton Bldg., 116 Nassau St., New York City.

KELLOGG, HENRY J. ....April, 1884
First Assistant City Engineer, New Haven, Conn.

KELLY, CASSIUS W. ....Jan. 9, 1900
City Engineer, New Haven, Conn.

KERSHAW, WILLIAM H. ....Feb. 9, 1909
Civil Engineer, Bridgeport, Conn.

KIRBY, RICHARD S. ....March 30, 1900
Instructor in Civil Engineering, Sheffield Scientific School, Yale University,
New Haven, Conn.

LAFORGE, FREDERICK W. ....Jan. 13, [illegible]
U. S. Engineer, Fort Terry, Plum Island, N. Y.

LANE, E. LEROY ....Jan. 8, 1901
Contractor, Hingham, Mass.

LANE, JOHN S. ....Jan. 8, 1901
John S. Lane & Sons, Meriden, Conn.

LANOUET, HENRY B., Associate Member ....Aug. 14, 1907
Civil Engineer, Waterbury, Conn.

LAW, WALTER H. ....Aug. 10, 1904
Civil Engineer, Woodside, Long Island, N. Y.

LAWTON, EDWIN F. ....March 30, 1900
Superintendent Hartford Electric Light Co., Hartford, Conn.

LEWIS, EVERETT W. ....Feb. 9, 1909
Civil Engineer, New Haven, Conn.

LEWIS, ROBERT P. ....Oct. 24, 1895
Secretary Blake & Johnson, Waterbury, Conn.

LIBBEY, JOSEPH H. ....Feb. 13, 1906
Assistant Electrical Engineer, N. Y., N. H. & H. R. R., West Newton, Mass.

LINES, FRANK H. ....Aug. 14, 1907
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

LOCHRIDGE, ELBERT E. ....Aug. 23, 1905
Chief Engineer, Water Supply, Springfield, Mass.

LOUNDES, RAWLINS ....Feb. 9, 1909
Assistant City Engineer, Waterbury, Conn.

LUTHER, FLAVEL S., JR. ....Feb. 9, 1904
President Trinity College, Hartford, Conn.

LYON, C. T. ....Feb. 12, 1907
Engineering Department, N. Y., N. H. & H. R. R., New Haven, Conn.

LYNCH, ALEXANDER S. ....Aug. 14, 1907
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

McBURNEY, HENRY ....Aug. 17, 1910
Bridge Engineer's Office, N. Y., N. H. & H. R. R., New Haven, Conn.

MAGILL, CLAUDE ....Aug. 14, 1907
Secretary Hassam Paving Co., New Haven, Conn.

MALONEY, DENNIS J.	April 20, 1901	Superintendent of Buildings, Board of Education, New Haven, Conn.
MALONEY, FRANK A.	Jan. 9, 1900	Assistant City Engineer, New Haven, Conn.
MANNING, GEORGE E.	Jan. 11, 1898	Civil Engineer, Yantic, Conn.
MARCHANT, ORSON H.	Feb. 14, 1905	Civil Engineer, New Haven, Conn.
McCONNELL, GEORGE B.	Feb. 9, 1909	Civil Engineer, New Haven, Conn.
McELROY, JAMES A.	Feb. 9, 1909	Civil Engineer, Bridgeport, Conn.
McKENZIE, J. M.	April, 1884	Civil Engineer and Surveyor, Yalesville, Conn.
McKENZIE, THEODORE H.	April, 1888	Sanitary and Hydraulic Engineer, Southington, Conn.
McKENZIE, THOMAS	Feb. 12, 1907	Superintendent of Water Works and Town Engineer, Westerly, R. I.
McKNIGHT, JOHN T.	May 31, 1893	City Engineer, Rockville. Residence, Ellington, Conn.
McLEAN, GEORGE H.	Feb. 9, 1904	Civil Engineer, New Haven, Conn.
MERRELS, CHARLES W.	Jan. 9, 1900	City Engineer's Office, New Haven, Conn.
MERRITT, MALCOLM	Aug. 12, 1908	Civil Engineer, Port Chester, N. Y.
MILLER, RODNEY B.	Feb. 9, 1909	Civil Engineer, New Haven, Conn.
MILLER, WILLIAM H.	Aug. 12, 1908	Civil Engineer, Waterbury, Conn.
MINOR, EDWARD E.	Feb. 9, 1904	Superintendent New Haven Water Co., New Haven, Conn.
MINOR, JUDSON M.	Feb. 13, 1906	Civil Engineer, New Haven, Conn.
MINOR, SHELDON E.	Sept. 25, 1886	Civil Engineer, Greenwich, Conn.
MITCHELL, ROBERT E.	Jan. 9, 1900	Civil Engineer and Surveyor, Willimantic, Conn.
MOORE, WM. HARLEY	Jan. 9, 1900	Engineer of Bridges, N. Y., N. H. & H. R. R., New Haven, Conn.
MORTON, WALTER S.	Aug. 10, 1904	Morton & Burritt, Civil Engineers, New York, N. Y.
MOSS, ERNEST B.	April 20, 1901	Civil Engineer, H. Wales Lines Co., Meriden, Conn.
MURPHY, HAROLD T.	Feb. 9, 1904	Civil Engineer, Springfield, Mass.
MURPHY, JOHN P.	July 18, 1899	City Engineer's Office, Hartford, Conn.
NASH, PAUL	Jan. 9, 1900	Superintendent Public Works, Stamford, Conn.
NICHOLS, CHARLES H.	Jan. 8, 1901	Consulting Engineer and Engineer of Shell Fish Commission, New Haven, Conn.
NOERR, ROBERT COLLYER	Feb. 12, 1907	Civil Engineer, Berlin Construction Co., Hartford, Conn.

NORD, CHARLES J. .... Feb. 8, 1910
Civil Engineer, Reynolds Bridge, Conn.

O'CONNOR, DON, Associate Member .... Feb. 9, 1904
D. F. Keenan, Hartford, Conn.

OLDERSHAW, FRANCIS H. .... Jan. 8, 1901
City Engineer, New Britain, Conn.

OLDS, HERBERT V. .... Feb. 9, 1909
Civil Engineer, Hartford, Conn.

OLMSTED, C. HENRY .... July 18, 1899
Civil Engineer and Surveyor, East Hartford, Conn.

OLSEN, JOHN .... Feb. 12, 1907
Civil Engineer, 82 Church St., New Haven, Conn.

ORROK, GEORGE A. .... Feb. 9, 1909
Civil Engineer, N. Y. Edison Co., 55 Duane St., New York.

OSBORNE, FRED H. .... Jan. 9, 1900
Civil Engineer Harrington Robinson Co., Boston, Mass.

OSGOOD, MAX .... Feb. 8, 1910
Civil Engineer, Pequabuck, Conn.

OWEN, ELIJAH H. .... March 30, 1900
Care of Vorce Engineering Co., Perry-Payne Bldg., Cleveland, Ohio.

PALMER, SHEPARD B. .... Jan. 8, 1895
Civil Engineer and Surveyor, Norwich, Conn.

PALMER, WILLIAM B. .... Jan. 13, 1885
Civil Engineer and Surveyor, Bridgeport, Conn.

PARDEE, WILLIAM S., Associate Member .... Aug. 10, 1904
Wright & Pardee, New Haven, Conn.

PARKER, GEORGE A. .... July 18, 1899
Superintendent of Keney Park, Hartford, Conn.

PARSONS, HAROLD A. .... Aug. 14, 1906
Civil Engineer, Stamford, Conn.

PATIENCE, FREDERICK G. .... Feb. 9, 1909
Civil Engineer, New Britain, Conn.

PATTON, ARTHUR J. .... Sept. 12, 1880
Land Surveyor, Waterbury, Conn.

PEARSON, ROBERT L. .... Aug. 14, 1906
Civil Engineer, Saugatuck, Conn.

PECK, ERMON M. .... Jan. 8, 1895
Assistant Engineer Hartford Water Works, West Hartford, Conn.

PECK, LEON F. .... Oct. 11, 1902
Civil Engineer, Greenwich, Conn.

PENDLETON, CLAUDIUS V. .... Aug. 10, 1904
Civil Engineer, Newark, N. J.

PENFIELD, GEORGE W. .... Jan. 8, 1901
Civil Engineer, Stamford, Conn.

PHELPS, JAMES W. .... Oct. 11, 1902
Landscape Architect, Bolton, Conn.

PIERCE, BRADFORD D., JR. .... Aug. 23, 1905
Civil Engineer, Bridgeport, Conn.

PIERCE, WILLIAM B. .... Feb. 9, 1904
Civil Engineer, Stamford, Conn.

PIERSON, STEPHEN C. .... Jan. 13, 1885
Civil Engineer and Surveyor, Meriden, Conn.

PIKE, WILLIAM K. .... Feb. 9, 1904
Civil Engineer, Danielson, Conn.

POEHLANDT, WALTER .... Feb. 12, 1907
Engineering Department, N. Y., N. H. & H. R. R., New Haven, Conn.

PORTER, HOWARD S. .... Feb. 8, 1910
Civil Engineer, Hartford, Conn.

PRESTON, CHARLES HENRY, JR. .... Feb. 12, 1907
Civil Engineer, Waterbury, Conn.

PUNDERFORD, JOHN K. .... Jan. 9, 1900
Gen. Manager Connecticut Co., New Haven, Conn.

REYNOLDS, WM. B. .... Aug. 14, 1900
Land Surveyor, Waterbury, Conn.

RICE, ARTHUR W. .... April, 1884
Treasurer Conn. Loan and Realty Co., Hartford, Conn.

RICHARDS, WALTER H. .... March 30, 1900
Engineer of Water and Sewer Department, New London, Conn.

RIGGS, GARDINER G. .... Feb. 9, 1909
Civil Engineer, Waterbury, Conn.

ROBINSON, HALBERT G. .... Jan. 11, 1898
Civil Engineer and Surveyor, Patten, Maine.

ROBINSON, LEONI W. .... Feb. 14, 1905
Architect, New Haven, Conn.

ROBINSON, SEYMOUR N. .... Feb. 9, 1904
Civil Engineer, Hartford, Conn.

ROGERS, CHARLES EDWIN .... Feb. 12, 1907
Prof. Civil Engineering, Trinity College, Hartford, Conn.

ROLLINS, ROBERT W. .... Jan. 9, 1900
General Manager Hartford Electric Light Co., Hartford, Conn.

RUFF, JOHN S. .... Feb. 12, 1907
Engineering Department, N. Y., N. H. & H. R. R., New Haven, Conn.

RYDER, ELY M. T. .... Jan. 9, 1900
Civil Engineer, 171 W. 95th St., New York, N. Y.

SAGE, GEORGE H. .... Jan. 8, 1895
Vice President Berlin Construction Co., Berlin, Conn.

SANDERS, JOHN .... Feb. 8, 1910
Civil Engineer, New Haven, Conn.

SAUNDERS, RICHARD L. .... Feb. 9, 1909
Assistant City Engineer, New Britain, Conn.

SCHILLING, ALBERT H. .... Aug. 14, 1906
Berlin Construction Co., New Britain, Conn.

SELLARS, PHILIP .... Feb. 9, 1904
Civil Engineer, New Haven, Conn.

SHAUGHNESSY, JAMES F. .... Feb. 11, 1902
Care of Board of Water Commission, New Hartford, Conn.

SHAW, GEORGE H. .... Aug. 23, 1905
Assistant Engineer Board of Water Supply, 299 Broadway, N. Y.

SHELDON, PAUL .... Feb. 12, 1907
Buck & Sheldon, Hartford, Conn.

SIBLEY, CHARLES A. .... Feb. 11, 1908
Contracting Engineer, New Haven, Conn.

SLOCUM, CURLYS L. .... Aug. 25, 1905
Civil Engineer, Penn. Tunnel and Terminal Railroad Co., 10 Bridge St.,
New York.

SMITH, FRINK M. .... Aug. 23, 1905
Civil Engineer, Danbury, Conn.

SMITH, GEORGE E. ....Feb. 1[illegible], 1903
Assistant City Engineer, Derby, Conn.

SMITH, WILLIAM G. ....April, 1884
Civil Engineer and Surveyor, Waterbury, Conn.

SNELL, EDWARD B. ....Feb. 13, 1906
Civil Engineer, New Haven, Conn.

SNELL, HARRY B. ....Jan. 8, 1901
Civil Engineer, New Haven, Conn.

SOEHRENS, JOHN H. ....Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New London, Conn.

SPENCER, NORMAN C. ....Jan. 8, 1901
Spencer & Washburn, Civil Engineers, Hartford, Conn.

SPENCER, WALTER T. ....Jan. 9, 1900
Division Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

SPERRY, A. WILLIAM ....Jan. 9, 1900
Civil Engineer and Surveyor, New Haven, Conn.

STEARNS, ELMER W. ....Oct. 11, 1902
Civil Engineer, Berlin, Conn.

STERLING, JULIAN ....Aug. 12, 1908
The Peck Bros. & Co., 2 West 94th St., New York.

STEVENS, ROBERT W. ....Feb. 8, 19[illegible]
Civil Engineer, Saybrook, Conn.

STERLING, PAUL ....Oct. 11, 1902
Civil Engineer, N. Y., N. H. & H. R. R. Co., New Haven, Conn.

STILES, EDGAR H. ....Oct. 11, 1902
Civil Engineer, New Haven, Conn.

STODDARD, RAYMOND FRENCH ....Jan. 9, 1900
Civil Engineer, Bridgeport, Conn.

STONE, EDWARD M. ....July 18, 1899
Civil Engineer and Surveyor, Hartford, Conn.

STORRS, HARRY W. ....Aug. 23, 1905
Civil Engineer, Bradley & Hubbard Mfg. Co., Meriden, Conn.

STORY, ISAAC M. ....Feb. 13, 1906
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

SULLIVAN, JOHN M. ....Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

TAYLOR, CHARLES F. ....Aug. 12, 1908
Civil Engineer, Windsor, Conn.

TAYLOR, EDWY L. ....Feb. 13, 1906
Civil Engineer, N. Y. C. & H. R. R. R., New York.

TAYLOR, LUCIAN A. ....June, 1884
Civil Engineer and Contractor, Boston, Mass.

TAYLOR, WILLIAM T. ....Feb. 9, 19[illegible]
Civil Engineer, Hartford, Conn.

TERRY, ALFRED H. ....Feb. [illegible], 19[illegible]
District Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

TERRY, JAMES ....Feb. 8, [illegible]
[illegible], Hartford, Conn.

THOMAS, JAMES E. ....Jan. 9, 1900
Civil Engineer and Surveyor, Hartford, Conn.

TONER, JAMES A. ....Aug. 23, 1905
Smith & Toner, Engineers and Contractors, Meriden, Conn.

TRACY, JOHN C. ....Jan. 9, 1906
Assistant Professor of Structural Engineering, Yale University,
New Haven, Conn.

TRACY, ROBERT R., Associate Member .... Aug. 17, 1909
Civil Engineer, Waterbury, Conn.

TRUESDELL, WALTER E. .... June 11, 1898
Civil Engineer, 7 West 38th St., New York, N. Y.

TRUMBULL, JOHN F. .... Aug. 10, 1904
Civil Engineer, N. Y., N. H. & H. R. R., New Haven, Conn.

TURNER, ALBERT M. .... Aug. 10, 1905
Civil Engineer, Canaan White Lime Co., Canaan, Conn.

UNKELBACH, MAX J. .... Jan. 9, 1900
Architect and Civil Engineer, New Britain, Conn.

VERRILL, GEORGE E. .... Feb. 11, 1902
U. S. Assistant Engineer, New Haven, Conn.

VORCE, CLARENCE B. .... Jan. 10, 1899
Civil Engineer, 52 William St., New York City.

WADHAMS, JOSEPH P. .... Feb. 9, 1904
Civil Engineer, New Haven, Conn.

WADSWORTH, A. R. .... Oct. 27, 1886
Civil Engineer and Surveyor, Farmington, Conn.

WARDWELL, FREDERICK S. .... Feb. 9, 1904
Civil Engineer, Stamford, Conn.

WASHBURN, ALBERT L. .... Jan. 10, 1899
City Engineer's Office, Hartford, Conn.

WATERMAN, CHARLES P. .... Feb. 11, 1908
Civil Engineer, Bristol, Conn.

WEAVER, HALSEY A. .... Jan. 12, 1897
Division Engineer, N. Y., N. H. & H. R. R., New Rochelle, N. Y.

WEBSTER, E. C. .... Feb. 11, 1908
Civil Engineer, New Haven, Conn.

WELTON, NELSON J. .... April, 1884
Civil and Hydraulic Engineer, Waterbury, Conn.

WESTCOTT, HARRISON R. .... Feb. 8, 1910
Civil Engineer, Bristol, Conn.

WHEELER, CHARLES A. .... Jan. 8, 1901
Prof. of Mathematics, Conn. Agricultural College, Storrs, Conn.

WHITE, HOWARD E. .... Feb. 9, 1904
New Haven Gas Light Co., New Haven, Conn.

WHITNEY, ELI .... March 30, 1900
President New Haven Water Co., New Haven, Conn.

WHITON, FRANK W., Associate Member .... Feb. 14, 1905
Architect, Hartford, Conn.

WIGGIN, ERNEST W. .... March 30, 1900
Civil Engineer, C. N. E. Ry., Hartford, Conn.

WILCOX, RALPH M. .... Jan. 8, 1901
Civil Engineer, Middletown, Conn.

WILKES, J. K. .... April, 1884
City Engineer, New Rochelle, N. Y.

WILLIAMS, PHILIP K. .... Aug. 14, 1906
Assistant Superintendent J. B. Williams Co., Glastonbury, Conn.

WOLCOTT, HENRY A. .... July 18, 1899
Mechanical and Civil Engineer, Hartford, Conn.

WOOD, CHAS. N. .... Aug. 14, 1900
Civil Engineer, Norwalk, Conn.

WRIGHT, FRANK W. .... Aug. 12, 1908
Card & Wright, Putnam, Conn.

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"I consider it the most practicable street cleaner for smooth pavement that I have ever seen. Its advantages over other flushing machines are that its sprinklers are under no heavy air pressure, so detrimental in my opinion to asphalt and other similar pavements, and at the same time there is practically no waste of water, as it is about all used by the heavy revolving rubber squeegee which washes the pavement so thoroughly as to leave no slime, mud or dust."—CHARLES J. POETSCH, City Engineer, Milwaukee, March 20, 1908.

"I am in receipt of your communication of August 10th, enclosing bill of lading for three (3) of your Street Washing Machines, which completes the order for ten (10) machines for this department. These machines are doing most excellent work, both in point of thoroughness and economy. We are making an extensive test with the machines, covering the street area cleaned, quantity of water consumed and cost of operation. When sufficient data is obtained I shall be glad to let you have a statement of the results."—FOSTER CROWELL, Commissioner of Street Cleaning, New York, August 18, 1908.

"I am pleased to give you the data procured by our test mentioned in my letter of August 18. We cleared 37,814 sq. yards in one day with one machine, and with a consumption of 143 gallons of water per 1,000 sq. yards, cleaned once."—FOSTER CROWELL, New York, December 23, 1908.

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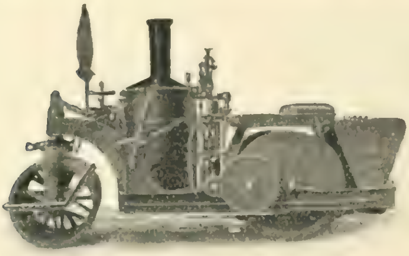

Double Drive Tandem Roller

Tandem Rollers
Asphalt Rollers
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Macadam Rollers
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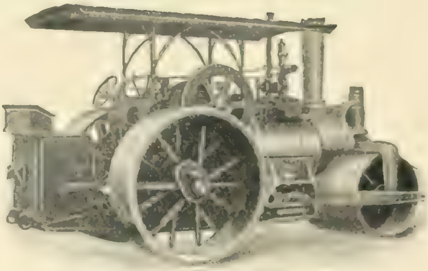

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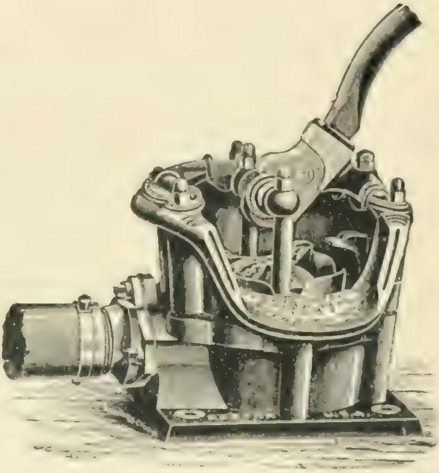

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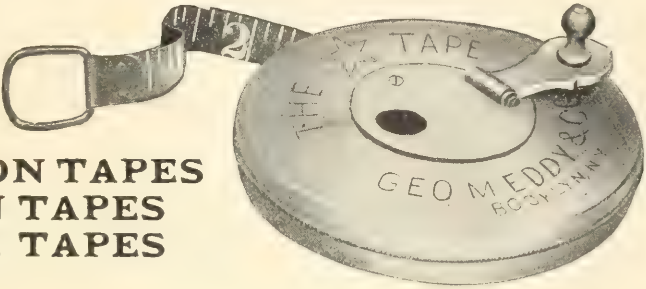

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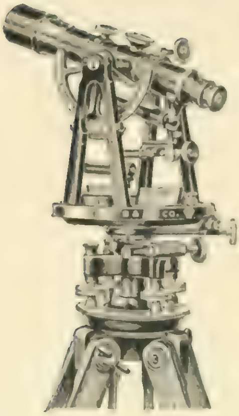

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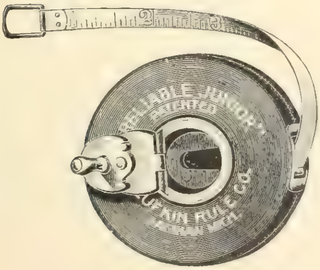

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1,500,000 Bbls. of these brands used exclusively in construction by Rapid Transit Subway Cons. Co. in New York City and Brooklyn

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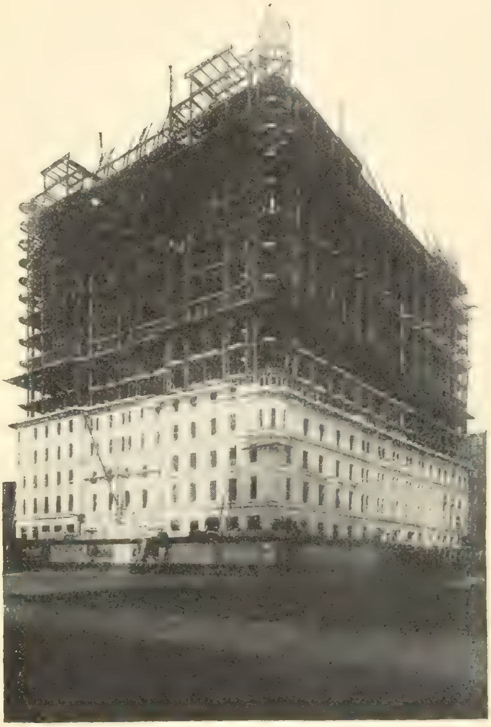

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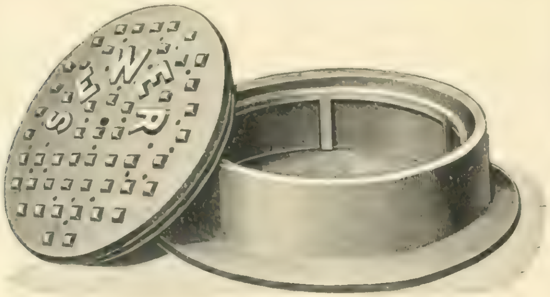

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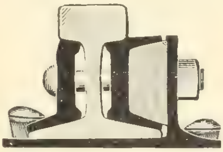

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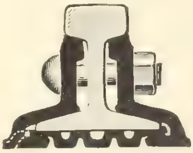

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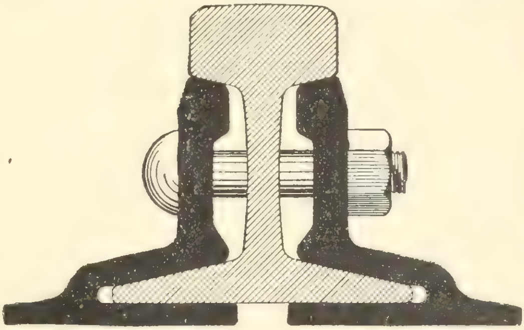

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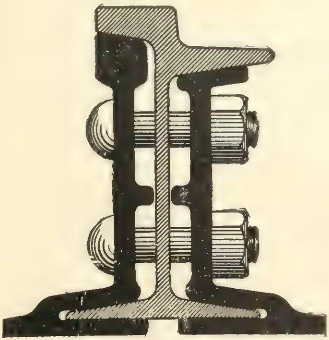

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Before construction was commenced, a careful study was made by the chemists of the Pennsylvania Terminal Co. of many waterproofing compounds, with the result that it was decided to use Coal Tar Pitch instead of Asphalt.

About 4,000,000 pounds of Barrett's pitch were used for underground work and roofing.

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THE RECOGNIZED
STANDARD
AMERICAN BRAND

Alpha Portland Cement Co.
NEW ENGLAND DEPARTMENT
521, 522 and 523 Board of Trade building
BOSTON, MASS.

F. N. KINNEY, Manager

The Leading Pavement

The following is an extract from the "Municipal Journal and Engineer," of March 4, 1908:

Relative Amounts of Various Pavements

"In New England we find eleven different kinds of paving, aside from macadam. Of these, stone block leads in quantity, and the others arrange themselves in the following order: gravel, brick, cobblestone, bitulithic, asphalt, Hassam, wood-block, asphaltine, asphalt block and bituminous macadam."

"Last year the largest amount of paving was stone block, followed by Hassam, gravel, brick, bitulithic and wood-block, in the order given."

HASSAM PAVEMENT ON OAK STREET, NEW HAVEN, CONN.
Laid by The Connecticut Hassam Paving Co.

Information and estimates for this most popular kind of pavement furnished on application to

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902 Chapel Street, New Haven, Conn.

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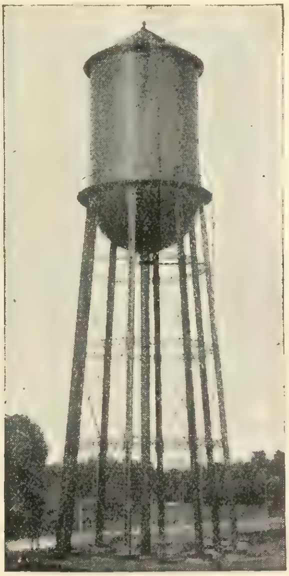
We are the builders of those hemispherical bottom elevated steel tanks which you have probably noticed in various parts of the country. We have done work of this character in 44 states and territories of the United States, in 6 of the provinces of Canada, in Mexico, Cuba, the Panama Canal Zone and the Philippine Islands.

The illustration shows a structure which we recently built for the Louisville Water Co., of Louisville, Ky. This is the largest tank of its kind in the world, having a capacity of 1,200,000 gallons and a height of 220 feet from the top of foundations to the maximum water line of the tank.



We are prepared to design, manufacture and erect these tanks of any practical dimensions in any part of the world.

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105th and Throop Streets :: Chicago, Illinois

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CALL, WRITE, TELEPHONE, TELEGRAPH OR WIRELESS, DAY OR NIGHT

MORE DURABLE THAN GRANITE

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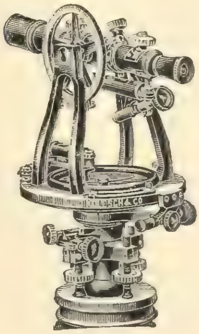

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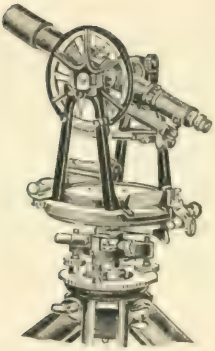

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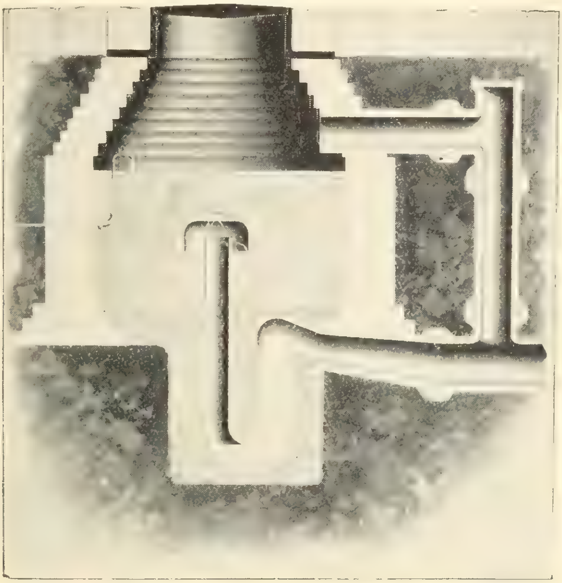

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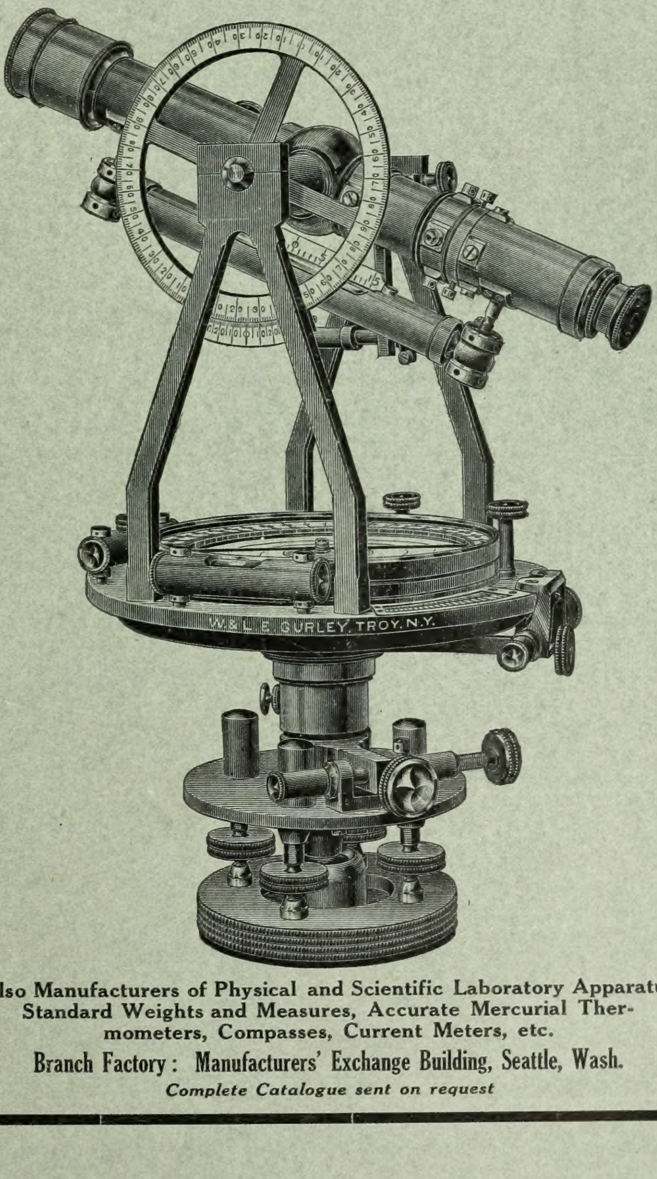
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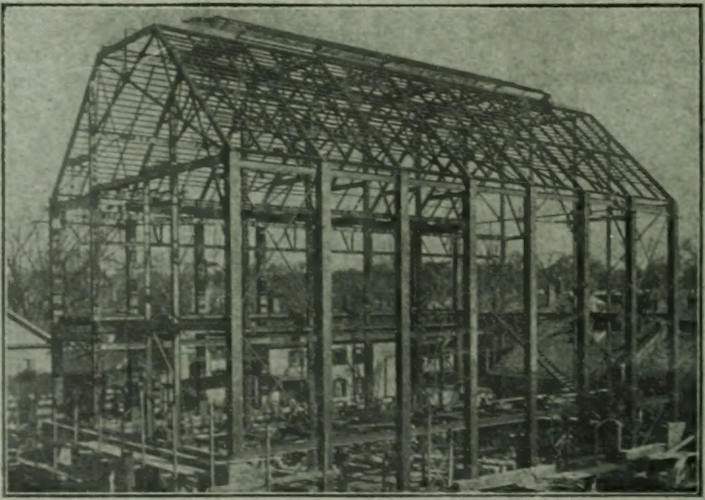

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